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A BRILLIANT BUT UTOPIAN DREAM.

WE are now fast approaching the summer of 1890, and the need for electric lighting generally will not be so keenly felt as during the dark days through which we have passed, although in the matter of coolness it may, in certain places, be even more desirable now than in the depth of winter. Our purpose, however, is not to institute comparisons between the seasons, but rather to draw attention to the time which elapses between the making of a promise and its fulfilment.

Before us is a cutting from the *Financial News* of October 24th, 1888, containing an article entitled "The Resurrection of Electric Lighting." The satire of the whole thing, as viewed at the present moment, lies in the fact that the saviour of the electric lighting industry was then discovered in the London Electric Supply Corporation. Its humble origin as an offshoot of the Grosvenor Gallery was alluded to in brief terms, but the exceptional scientific and businesslike abilities of Lord Crawford and his friends were enlarged upon in such a manner as must have caused a blush to mantle his lordship's countenance. We were then assured, in a manner evidently inspired by those who knew, that in a few months the whole of central London, from Kensington to the Monument, would have the electric light placed within its reach, and that from a huge manufacturing centre at Deptford the electric current would be distributed through every leading thoroughfare of the metropolis. Eighteen months have passed away, and we seem to be no nearer the grand *coup* which the *Financial News* evidently considered was then on the point of approaching finality, and the movements of the London Electric Supply Corporation are creating a feeling akin to alarm in the minds of the public interested in the future of the electric lighting industry.

If, as a correspondent to *Industries* said last week, "The Deptford electric light station proves a failure owing to the cables not being satisfactory, there is no doubt that it will have an injurious effect on the public mind as regards electric lighting in general." That the cables, so far, have proved to be unreliable is well known, and it is equally patent to everybody that before success can be assured conductors must be laid capable of sustaining the strain put upon them. But why does Mr. Forbes hint that the Corporation may have recourse to law to recover damages for unworkable construction or want of skill? Surely these firms who have supplied him with cable have done so under definite specifications, and we can hardly think it possible that any of them were rash enough to guarantee a perfect insulation on a long length of line subjected to a 10,000-volt pressure. Until we learn more of the conditions under which the supply of leads was carried out, we cannot entertain the idea that the breakdowns should be credited to the manufacturers, and we trust, that Mr. Forbes will not, for his company's sake be tempted to try conclusions in a court of law. People might be unreasonable enough to think that such a proceeding was akin to making a scapegoat of somebody for failures which were predicted long ago, although the warnings were culpably ignored. Still, as the writer above mentioned very pertinently remarks, the names of those cable manufacturers who turn out bad work and disobey instructions ought, in justice to other central station engineers, to be made public. However, we give Mr. Forbes credit for considerable astuteness, and we therefore assume that his half threat was "one of those indefinite assertions frequently made by chairmen at company's meetings."

One weekly organ which seems to implicitly believe in the Ferranti mains, says that the reports of their failure are entirely devoid of foundation. "Recently a length of main, consisting of some 30 or 40 lengths, was tested with transformers up to 18,900 volts without failure. The mains are considered quite satisfactory, and tons of the lengths are being manufactured." Now, it will be remembered that the Ferranti conductors are built up in sections of 20 feet, so that the maximum length tested could not, if our contemporary is correct, have

exceeded 800 feet, less than $\frac{1}{5}$th of a mile. This conductor, we may add, simply extended round the central station, and cannot, therefore, be considered in the light of a practical test for duration.

"The engineers avow themselves thoroughly satisfied with the result both of the dynamos and the mains, and the work has all been carried out as originally proposed and determined." We would ask whether any of the engineers have had any greater experience than Mr. Ferranti himself; if not, how much value should be attached to their opinions? Are they not all learning the lesson of bitter experience which all young enthusiasts who will not listen to the advice of those who have been through the mill, must acquire?

It is really time that something should be done to enable the public to accurately gauge the chances of the Deptford installation. The Corporation gives but little definite information, and rumour may in consequence be exaggerated; it is, therefore, to the interest of Mr. Forbes and his co-directors to state frankly the position in which they find themselves.

"It is roughly estimated," said the inspired article in the *Financial News*, "that London requires an average of one light per head of the population—say, five million lights. The Earl of Crawford's company has put its shoulder to the herculean task of supplying at least one-half of the five millions. The prosaic reader may shake his head at this as a brilliant but Utopian dream. All we have to reply is that there is going to be nothing dreamy about the 10,000 horse-power engines, or about the dynamos 40 feet high, which are to be coupled with them, or about the electric cables which are to be run into London over all three of the Southern railways, and to radiate from every railway terminus from Cannon Street to Kensington." . . . "In its manufacture electric light is doubtless dearer than gas, but in distribution it should be much cheaper, and in maintenance there ought to be no comparison between them."

In the face of all this, what has the Corporation to say on the results of the past eighteen months?

We fear that if the truth were known there is no comparison between them, only that gas takes the place which our financial contemporary allotted to the electric light. Let it be understood, however, that we in no way venture to think this is the case with other companies who supply electrical energy.

Another Primary Battery.

A REMARKABLE paragraph, emanating from its Madrid correspondent, appeared in the last issue of *Industries*. Reference was made to a system of electric lighting with a new primary battery invented by a Major Cabanyes, but no technical details were given as to the nature of the battery. The correspondent, in referring to a public exhibition of the battery, says:—"Of course, some very extensive details were given as to the commercial value of the system, and it is quite possible that it could compete with the dynamo central stations which are now being erected in Madrid, on account of the absurdly high prices demanded by the latter." The highest price to be charged in Madrid is 1s. 4d. per 1,000 watt-hours, and this corresponds to gas at 13s. 4d. per 1,000. The correspondent's statement, which was doubtless published in the absence of the electrical editor, is about as valuable as that of most others in regard to primary batteries.

Technica Book Illustrations.

IN a critical article on "Samples of Current Electrical Literature" in our contemporary, *Nature*, the writer draws attention to an illustration of an apparatus for ascertaining the laws of the production of a current in a coil by the insertion or withdrawal of a magnet, in which the coil is represented as being so close to the galvanometer that the movement of the magnet itself would, by its direct influence on the needle, affect the latter and apparently indicate the passage of a current. The general question of illustrations for scientific books is an important one, and is one to which sufficient attention is not, as a rule, paid; there is scarcely a single text book on electricity, for example, in which we do not find in the chapter on "Telegraphs," illustrations of apparatus which are utterly unlike those that are actually in use. A very little trouble would save all this and vastly add to the utility of the book.

Central London Railway Bill.

AS our readers will see in "Notes" columns the Central London Railway is the subject of an official enquiry by a select committee of the House of Commons. There has been an organised opposition, from the inception of the scheme, by tradesmen along the line of route who expect a reduction of business, by vestries who deemed they had a right to be heard, and by property owners who consider their possessions in danger. Looking, then, at the nature of the opposition, we find it has little of reason to recommend it. The railway, if built, will not be used from end to end by shoppers, but rather by those whose business it is to get to the busy haunts of men as quickly as conveyance will carry them, whether by omnibus, cab, or railway, therefore we fail to see the anticipated loss of business, unless shopkeepers consider travellers to and from the City by seeing their wares become customers. The vestries, of course, are almost bound to oppose any scheme of which they are not the originators, so it counts for little. The strongest argument will be brought by those who are the owners of valuable buildings which lie along the intended line, but as the engineer, Mr. Greathead, says, this feeling of fear should cease to exist, when it is guaranteed that at no point will the top of the tunnel be within 30 feet of the bottom of any cellar.

The London County Council.

A CERTAIN Mr. Jasper H. E. Nicolls has published a brochure advocating the purchase of the London tramways by the County Council; he particularly advocates that the Council should not allow the Bills now being promoted by two of the companies for the purpose of adopting electric traction to be passed without certain conditions, it being argued that if these conditions are not insisted on, the Council will afterwards have considerably more to pay to buy the companies out. The advisability of the Council acquiring the tramway system would, we imagine, be endorsed by few. That

the ratepayers would gain generally by such an arrangement we much doubt; the tramway system is not, like the penny post, a universally used institution, and probably the majority would object to be taxed for the benefit of the few, especially as the proceedings of the County Council have, up to the present time, not shown that vast improvement over the defunct Metropolitan Board of Works, either as regards economy or efficiency, which was promised.

The Opinions of Experts.

THE opinions of the English authorities on high tension underground circuits which we reproduced last week from the New York *Electrical Engineer*, are either thought to be of very little value, or else the subject is too difficult for others to handle. We expected that quite a number of correspondents would have taken this matter up, but nobody seems to be able or willing to do so, although there is much in the replies to call for comment. If the London Electric Supply Corporation would formulate a similar series of questions applying to the 10,000 volt scheme and the Ferranti conductors it might, perhaps, bring forth a series of answers of value to the electric lighting industry here; those of last week applied mainly to American practice.

Insulation.

THE transactions of the Insurance and Actuarial Society of Glasgow contain a paper, just issued, on "Fire Risks due to Defective Installations of the Electric Light," by Prof. Andrew Jamieson. The lecturer was very careful to insist upon good insulation with a material which should be of uniform quality throughout, impervious to damp or changes from a humid to a dry atmosphere, and lasting in its qualities. Quite recently he had been called upon to inspect some leading wires which had been eaten through in the following peculiar manner:—The wires had been run underneath the urinal of a w.c. without any other protection than a *single* coating of pure rubber strip and the usual serving of cotton and tape common to low-class insulated conductors. Some urine had found its way to the conductor through the imperfect insulation, with the result that the conductor was eaten away to *less than* half its original dimensions, and fused before even bringing into aid the "cut-outs" or safety fuses. Both forward and return leads were close together, and an evident partial short-circuiting of the current had also taken place. The building was thus jeopardised, and yet it was duly insured by one or more insurance companies without ever having been inspected by a qualified expert before the insurance was effected.

Importance of Perfect Joints.

PROF. JAMIESON, who, as our readers are aware, gained much of his experience as a submarine cable expert, is very hard upon the usual manner of jointing electric light conductors:—He says:—"You may have the best conductors covered with the very best and most lasting material, but unless the joints are thoroughly well made and equal in insulation resistance to at least the same length of the cable or branch leads, leakage or even a serious fault may occur at them. I have never yet met with a *really* skilful electric light contractor's jointer. In the manufacture, laying, and repairing of submarine cables, the jointer is well paid, and never hurried or badgered to push on with his work. He is, moreover, never permitted to make important joints until he has proved himself thoroughly competent for the work by long practice on specimen joints, under the supervision of the leading jointer or the electrician in charge. Some men will never make good jointers, from their naturally careless, dirty, slovenly habits. The good jointer keeps his hands, tools, and materials beautifully clean and in good working order; in fact, he takes a special pride in his craft. He feels that he has a reputation to keep up, and he would rather forfeit a week's pay than make a bad joint. Submarine cable joints are, whenever possible, tested with at least 100 times the normal working pressure, and not passed unless they are equal in insulation resistance to at least double the length of standard cable core. Electric light contractors would do well to take a lesson from the rigid but necessary system of perfect jointing, more especially in the case of high-pressure alternate current circuits." During the lecture specimens of faulty joints were handed round. These joints had been cut out by the lecturer from several installations in the course of his official inspections, and they were severely commented upon by him. Specimens of thoroughly well made and reliable joints, as supplied by the India-Rubber and Gutta-Percha Company, of Silvertown, in accordance with their diagrams and directions, found in Munro and Jamieson's Pocket-book, pp. 230 to 234, were also exhibited, as well as the joints in the new Fowler-Waring cables. All that Mr. Jamieson insists upon here has been brought before the notice of our readers over and over again, but it seems to necessitate the authoritative stamp of a Professor to bring these self-apparent truisms home to the multitude; if, therefore, electrical contractors are made more careful by reading these strictures upon their work, we shall consider the space we devote to the subject of this lecture not taken up uselessly.

Coincidences.

WE may mention here, curiously enough, that just as Prof. Jamieson has finished the pamphlet from which we have quoted, he read our last week's leader, and the ideas there formulated correspond, he says, entirely with his own.

Fire Risk Rules.

WE do not think that anyone will care to question the truth of Prof. Jamieson's comments upon fire rules and regulations. He has come to the conclusion, after due consideration, that it is not worth while, except as a mere advertisement, for more insurance companies rules, since they have those issued by the Institution of Electrical Engineers, by which they can always demand that the work shall be done, and if a contract is carried out, in full accordance with the same, there can be little or no fear from fire risks. The Phœnix Fire Office rules have been of great service, and they are in many respects most complete and praiseworthy, but they leave so much to the discretion of their inspectors, that unless they are all skilled electricians, with a complete knowledge of all the technical details, and capable of taking accurate electrical tests with their own or certified apparatus in an unbiased manner, they will find it difficult to thoroughly enforce and check them in every detail. The Westminster Fire Office rules seem to Mr. Jamieson to be easier of application, as there is no mention whatever of requiring the inspector's opinion, and they have the further merit of conciseness without being hampered with many riders.

RESEARCHES ON THE ELECTRIC PROPERTIES OF RAREFIED AIR.

ALL modern electricians who keep themselves abreast of the times are familiar with the excellent work of Prof. Poynting and of Mr. Oliver Heaviside, the wide scope of whose investigations into difficult fields of research form a remarkable example of the power with which the problems of science are being grappled with at the present day. Prof. Poynting has done much to develop the splendid mathematical results of the late Clerk-Maxwell, whose name stands pre-eminent amongst the representatives of the great English school of mathematical physicists. He has taught us how to distinguish between the flow of electricity and the flow of electrical energy, and has thrown much light upon the manner in which electro-magnetic energy is transmitted. Of Mr. Heaviside we may say, borrowing from a sentence in Prof. Oliver J. Lodge's lecture on "The Discharge of a Leyden Jar," "his profound researches into electro-magnetic waves have penetrated further than anybody yet understands into the depths of the subject, and whose papers have very likely contributed partly to the theoretical inspiration of Hertz."

Evidence of the accuracy of Prof. Lodge's estimate of Mr. Heaviside's work, as far as it affects the splendid generalisation and experimental results of Dr. Hertz, of Carlsruhe, is continually being brought forward. Quite recently Dr. Hertz has succeeded in obtaining an experimental realisation of one of the ideas held in common by Prof. Poynting and Mr. Heaviside concerning electric oscillations, *vide* Wiedemann's *Annalen der Physik und Chemie*, T. xxxvii., p. 395.

It is believed that the electric oscillations in a wire take their origin at its surface; that they are extremely rapid, and that, while remaining practically superficial in character, they penetrate more or less into the interior. Dr. Hertz devised a sort of cylindrical cap which should serve to figure the conducting wire; twenty-four very fine wires were arranged between two metallic discs, the centres of which were connected by means of a sort of metallic axis which could have its metallic continuity interrupted by a "sparking" micrometer placed on the axis. With this arrangement Dr. Hertz has succeeded in demonstrating that an electric oscillation does confine itself practically to the surface of a conductor, for it does not produce sparks in the micrometer that is placed on the axis which traverses the centre of this conductor.

These experimental results have induced M. J. Moser to direct his attention to the action of electric oscillation in rarefied air. In his investigations, the results of which were communicated to the Paris Academy of Science on February 24th,* 1890, he used rarefied spaces, without any metal or electrode of any kind, as conductors for the oscillations.

It has often been observed that tubes of rarefied air become luminous when they are in the immediate neighbourhood of an induction coil that is being worked, but such tubes, according to all accounts, have been of the Geissler type, and have consequently been furnished with metallic electrodes which traversed the glass, or with electrodes which were simply applied to the exterior surface of the glass, like those of Gassiot. Moser's experiments, however, were carried out with tubes which were not then provided with metallic electrodes. The presence of the electrodes has hitherto always complicated the attempt to explain the phenomena which occur, and Moser believes that the elimination of these disturbing factors will tend to simplify the solution of many difficult problems in physics.

The arrangement devised and adopted by Moser was as follows:—A glass tube of air, 40 cm. long and 3 mm. in diameter, had its contents rarefied by means of a Geissler pump, after having been sealed off before the blow-pipe; this tube was then enclosed in another glass tube of 10 mm. diameter, and rather more than 40 cm. in length. The exterior tube was sealed up at one end, and at the other it was hermetically connected with a Geissler air pump. The rarefaction of the inner tube remains, of course, invariable, whilst that of the outer tube can be varied at pleasure.

When such an arrangement is brought into the neighbourhood of an induction coil in action the inner tube becomes brilliantly luminous, showing a clear blue colouration without any lines of stratification if the outer tube has not yet been exhausted. When, however, the outer tube is exhausted, and its rarefaction varied, whilst that of the inner tube remains always constant, some remarkable phenomena are noticed, accompanied by unexpected variations in the colour of the luminosity.

These seem to show, according to Moser, that three states of rarefaction are to be distinguished, these states of rarefaction being characterised by different electrical proportions. Thus air which conducts the induced charge when it is at a pressure of 1 mm. becomes insulating when the rarefaction is carried to the extreme limit—in fact there are three states of rarefaction which may be described as

I. Ordinary vacuum (insulating).
II. Vacuum 1 mm. pressure (conducting).
III. Extreme vacuum (insulating).

It is a well-known fact that Geissler tubes, which are furnished with metallic electrodes, after having been subjected to extreme rarefaction, refuse to conduct the passage of the electric discharge, and this phenomenon has been the subject of much discussion. Some physicists have explained it by supposing the vacuum to possess insulating properties; whilst others, again, have attributed it to a property of the surface of the electrodes, assuming that they offer, under certain circumstances, great resistance to the passage of the discharge. In Moser's experiments there are no electrodes, so this latter theory breaks down, and the phenomena cannot be due to the resistance and passage at the surface of the electrode. It is indirectly connected then in some way with the properties of vacuum.

Since the results of these experiments were communicated M. Moser has been directing his attention to the study of the specific inductive power of spaces of rarefied air, and he gave an account of his more recent investigations to the Academy of Science at Paris about a fortnight ago.

The specific inductive power was measured in relation to the then states of rarefaction, which have been already alluded to. In studying the problem Moser made use of the following apparatus:—A large Leyden jar was constructed with a double bottom and double sides in such a way that it was possible to rarefy the air in the annular space between the double sides. The internal surfaces of the glass, which limited the air in the annular space, was covered with layers of silver foil; these layers served as armatures; they were insulated, the one from the other, and communicated with the exterior by means of electrodes. The layer of air between these armatures formed, as it were, the dielectric.

A Geissler pump was connected with the Leyden jar in order to produce the necessary degrees of rarefaction, and these by means of a well-known device could be easily measured. The pump was also connected up with the system of concentric tubes which are described in the first part of the paper, and which was used to demonstrate the variation in the conducting power of varying degrees of rarefaction. An ordinary Geissler tube was also connected up, by exciting which it was possible to estimate the extent of the rarefaction when the manometer showed no appreciable alteration of level.

Moser then determined the conductivity and also the specific inductive power of this system of rarefied spaces, all disturbing influences being carefully allowed for or eliminated. The measurements were then made by well-known methods, the only difficulty being the precaution necessary to be taken in order to avoid error. In these measurements a quadrant electrometer was used of the kind known as the Mascart-Carpentier, and with the induction coil and the constant battery a Sabine key was employed.

* See ELECTRICAL REVIEW for March 7th.

In one series of experiments the quadrants of the electrometer were charged with five Latimer-Clark elements, and the Leyden jar by means of 150 voltaic elements consisting of zinc, water, and copper, but wishing to simplify matters, and at the same time to intensify the results for which he was seeking, M. Moser eventually charged the Leyden jar with a Zamboni pile and the quadrants by means of a simple Latimer-Clark element. The deviation of the electrometer is the function of a product, and by modifying the experiment in the way thus indicated Moser succeeded in increasing the factor which he wished to observe, whilst at the same time preserving the value of the product. The jar was always charged for exactly the same time—namely, one minute—so that the results were strictly comparable.

For these states of rarefaction the following deviations were observed :—

I. 10 mm. of Ho_2	II. 1 mm. of Ho_2	III. Extreme vacuum.
318	318	318
318	320	320
318	320	320

These results conclusively demonstrate that there is practically no variation of the specific inductive power when the rarefaction is varied.

Spaces of rarefied air therefore exhibit two remarkable electric properties—namely, the variation of their conductivity, and at the same time the constancy of their inductive power.

STATISTICS OF ELECTRIC LIGHTING IN MASSACHUSETTS.

THE total capitalisation of 102 electric light companies doing business in the State is $4,837,085. During the year 15 companies paid dividends varying from 1 to 21 per cent., this last including an extra dividend of 15 per cent. The total amount of the dividends was $172,372 10c., which, on the basis of the total capitalisation of 102 companies, is equal to about 3·56 per cent.

The first electric light company incorporated in the State was the Lowell Company in 1881, that being the only company incorporated that year. In 1882 there were three companies incorporated, at Lawrence, Salem, and Taunton ; in 1883 there were four companies incorporated, at Brockton, Fall River (2), and Worcester ; in 1884 one company at New Bedford ; in 1885, three ; in 1886, 13 ; in 1887, 14 ; in 1888, 31 ; and in 1889, 54.

On June 30th, 1889, there were in use in the State for electric light purposes by incorporated companies 171 boilers rated at 19,925 horse-power, 199 engines of a total rated capacity of 18,812 horse-power, and 358 dynamos. Water-wheels were used to the amount of 545 horse-power, while four companies used leased power and three bought the steam used in their engines. One company used three 45 horse-power gas engines. Of course these figures do not include the power or apparatus used in isolated lighting, but only that of central stations.

On the same date the electric light companies had in use 14,412,043 feet of wire, 100,205 feet of conduit, 330,196 feet of underground wire, and 28,548 poles set in the streets. All of the underground wire is, according to the report, in Boston, Fall River, Lawrence, New Bedford, and Springfield. No returns are given for the underground wires in Brockton. The Boston Electric Light Company has in Boston, in addition to 830 poles, 1,030 roof fixtures.

The number of single carbon arc lamps in use was 5,463 and of double carbon lamps 3,375. Plain carbons were used to the number of 1,086,477 and copper-plated carbons to the number of 2,776,746. Ten companies used over 100,000 carbons each, the largest consumer being the Boston Electric Light Company, which had 1,134 single carbon lamps and 1,263 of the double carbon type in use, and used a total of 1,445,087 carbons. Counting each double carbon lamp as two, the above figures would give a total of 12,213 lamps and 3,063,223 carbons, or an average of about 316 carbons per lamp per year.

The total horse-power of electric motors in use on June 30th, 1889, was 1,442, furnished by 538 motors, of which 111 were on arc light circuits, 379 on incandescent light circuits, and 48 on power circuits. These motors were run from only 21 different stations, 11 of which were supplying over 40 horse-power each. The station supplying the largest amount of power was the Edison station in Boston, supplying 233 motors, aggregating 623 horse-power—nearly half of that supplied in the entire State. These were all on incandescent circuits.

The various systems of lighting, both arc and incandescent, were represented in the State as follows :—

Of 2,000 candle-power : Thomson-Houston, 3,960 lamps ; Brush, 1,563 ; American, 975 ; Schuyler, 501 ; Arnoux-Hochhausen, 54. Of 1,800 candle-power : Waterhouse, 40. Of 1,600 candle-power : Ball, 130. Of 1,500 candle-power : Schuyler, 35. Of 1,200 candle-power : Thomson-Houston, 3,851 ; Schuyler, 270 ; Brush, 180. Of 800 candle-power : Ball, 140. Of 20 candle-power : Thomson-Houston, 3,400. Of 16 candle-power : Edison, 36,200 ; Thomson-Houston, 30,150 ; Westinghouse, 10,700 ; Weston, 1,525 ; Sun, 900 ; Brush, 600. Of 15 candle-power : Edison, 880.

The following table shows the number of electric lights of various candle-power represented by the dynamo capacity of the companies, June 30th, 1888, and June 30th, 1889 :—

	1888.	1889.
15 candle-power	880	880
16 " "	52,075	80,075
20 " "	1,200	2,800
800 " "	—	140
1,200 " "	2,757	4,206
1,500 " "	—	35
1,600 " "	110	130
1,800 " "	—	40
2,000 " "	5,846	6,978

Arc lights were furnished for commercial use by 57 companies. The total number of consumers was 1,223, and the number of lights furnished 3,916, or an average of 3·2 lights per customer. Of these lights 2,643 were of 2,000 candle-power, 1,245 of 1,200 candle-power, 1 of 1,600 candle-power, 1 of 1,500 candle-power, and 26 of 800 candle-power. The largest furnisher of commercial lights was the Boston Electric Light Company supplying 1,210 lamps of 2,000 candle-power.

There were 2,438 incandescent lights furnished for commercial purposes off arc light circuits to 363 consumers. Of these 698 were of 16 candle-power, 188 of 20, 540 of 25, 337 of 32, 112 of 50, 472 of 65, and 91 whose candle-power is not given. Assuming these to be of the smallest size, 16 candle-power, this will make a total of 76,948 candle-power, or an equivalent of 4,809 16 candle-power lamps, or an average of 13·2 to each customer furnished.

From incandescent circuits there were furnished a total of 72,406 lights divided as follows :—64,575 of 16 candle-power, 5,058 of 20, 2,084 of 10, 336 of 25, 181 of 24, 135 of 32, 20 of 50, 7 of 100, and 5 each of 13 and 30 candle-power. These make a total equivalent of 73,386 16 candle-power lamps, and were furnished to 5,270 customers, or an average of 13·9 to each. These are furnished by 49 companies, only 8 of which furnish incandescent lights exclusively. Thirteen of these companies have over 100 customers for incandescent lights.

Sixty-one different companies were at the end of the year furnishing to as many cities 7,494 public electric lamps. These lamps were of 16 different candle-powers, the number of lamps of each candle-power being as follows :—429 of 15 candle-power, 189 of 16, 446 of 20, 1,503 of 25, 164 of 30, 61 of 32, 200 of 40, 13 of 50, 17 of 65, 31 of 125, 70 of 800, 1,646 of 1,200, 26 of 1,500, 60 of 1,600, 30 of 1,800, and 2,609 of 2,000 candle-power ; a total of 3,053 incandescents and 4,441 arcs.

Twenty-three cities use arc lights of 2,000 candle-power, the largest consumer being the City of Boston with 935 lamps, while 33 cities are lighted by lamps of 1,200 candle-power, Malden, with 166, being the largest consumer.

ON THE EXCITEMENT OF ELECTRICITY AND HEAT IN ELECTROLYTES.

By MAX PLANCK (*Annalen der Physik und Chemie*).

(*Continued from page* 424.)

Section 4.—*Production of Heat.*

WE now turn our attention to the transformation of energies as it occurs in an electrolytic solution of unequal concentration and traversed by currents utilising the foregoing equations. We inquire first as to the different kinds which may possibly come into play. Within the solution there exists, in the first place, the electrostatic energy derived from the effects of the free electricities, though it is evidently vanishingly small.

Its magnitude is of the order $\rho_s^2 = \rho^2 c_2$ and consequently it does not come into consideration, since ρ has been previously shown to be of the order $1/c^2$.

Secondly, we must consider a form of energy which arises from the interaction of electricity and ponderable matter, and which I have designated as intermolecular energy. But this also disappears here since the ions retain their electric charges unchanged. Thereby the potential molecular energy falls away since all the ions are constantly dissociated and move independently, as does also the kinetic energy of the movement which contains the squares of the velocities of the ions.

Heat alone, therefore, remains for our consideration. All the processes of energy within the electrolyte are confined to thermic phenomena, to the computation of which we now proceed. We may here proceed in a twofold manner: we may either directly consider the thermic processes occurring in any spacial part of the solution, or we examine merely the processes on the surface of the space and utilise the well-known proposition that the transformation of energy of any system is measured by the energy introduced into such system from without. We will employ successively both methods, and, in the first place, the more direct one.

It is established by observing the effects of a current which flows through an electrolyte of a uniform concentration, that positive heat (Joule's heat) is produced in its interior and arises quite in the manner of the heat of friction, and it is hence commonly ascribed to a friction between the moving ions and the solvent. The facts are satisfying if the heat produced is taken as equal to the work which the moving forces perform in all the ions. This proposition must, therefore, come into application in our more general case, where we have to do not only with the electrostatic forces resulting from the fall of the potential, but also with the osmotic differences of pressure. In calculating the heat of friction it can make no difference whether and to what extent the motive power is of electric or osmotic origin. The heat of friction must be assumed equal to the work of the entire motive power, the same power by which the velocity of the ions is determined. Hence we obtain, by multiplying the three components of force with the corresponding speed-components, as they have been calculated above, the following positive expression for the heat of friction which is produced in the time, $d\,t$, from the positive ions of the first kind contained in the space $d\,\tau$:

$$\left[\left(\frac{\mathrm{R}}{p}\frac{\delta p}{\delta x}+\varepsilon\frac{\delta \phi}{\delta x}\right)^2+\left(\frac{\mathrm{R}}{p}\frac{\delta p}{\delta y}+\varepsilon\frac{\delta \phi}{\delta y}\right)^2+\left(\frac{\mathrm{R}}{p}\frac{\delta p}{\delta z}+\varepsilon\frac{\delta \phi}{\delta z}\right)^2\right]$$

$$u\,.\,\frac{p}{\mathrm{R}}\,d\tau\,.\,d\,t$$

to which similar expressions attach themselves for the remaining positive and for the negative ions. The sum of all these expressions gives the heat of friction produced in the time dt, and in the space $d\,\tau$.

But whence is this friction-heat derived? It can originate only, either at the expense of some other form of energy in the interior, or by the entrance of external efforts. In case of a solution of uniform concentration where osmotic forces are absent the "Joule's heat" is supplied by external electric forces which drive the electricity from higher to lower potential values through the solution. But here this electric work is generally insufficient to explain the calculated heat, as the osmotic forces likewise put the ions in movement and produce frictional heat. So long, therefore, as we stop at the assumptions made the calculation of the heat contradicts the principle of energy, and we leave a defect in our representation which must necessarily be supplied.

It is, in fact, possible to supply this deficiency by a new and simple supposition, *i.e.*, by the hypothesis that the analogy existing between the behaviour of the dissolved ions, and that of the molecules of a gas extends also to the production of heat by compression or dilatation.

If the ions are compressed by the osmotic pressure, there is liberated an amount of heat equivalent to the work of compression and inversely by the expansion of the ions overcoming the osmotic pressure a corresponding quantity of heat is absorbed.

The assumption, as it will be shown in the next paragraph, is in perfect harmony with the principle of energy. From what has been said it is easy to calculate the heat of compression in any part of the solution. We only need for every kind of ions to multiply the decrease of volume by the osmotic partial pressure. Thus by a brief calculation we arrive at the following expression for the heat of compression which is produced in the time, $d\,t$, by the positive ions of the first kind contained in the spacial element $d\,\tau$:

$$\left[\frac{\delta}{\delta x}\left(\frac{\mathrm{R}}{p}\frac{\delta p}{\delta x}\right)+\frac{\delta}{\delta y}\left(\frac{\mathrm{R}}{p}\frac{\delta p}{\delta y}\right)+\frac{\delta}{\delta z}\left(\frac{\mathrm{R}}{p}\frac{\delta p}{\delta z}\right)+\varepsilon\,.\,\Delta\phi\right]$$

$$u\,p\,d\,\tau\,.\,d\,t,$$

&c., for the remaining positive and for the negative kinds of ions. By summation we obtain the total heat of compresson in the spacial element $d\,\tau$.

By putting together the expressions for the heats of friction and compression we obtain the entire heat produced, and in the first place, as far as it springs from the positive ions of the first kind by the addition of the two last formulæ.

$$\Big\{\mathrm{R}\,.\,\Delta\,p+2\,\varepsilon\,.\left(\frac{\delta p}{\delta x}\frac{\delta \phi}{\delta x}+\frac{\delta p}{\delta y}\frac{\delta \phi}{\delta y}+\frac{\delta p}{\delta z}\frac{\delta \phi}{\delta z}\right)+\varepsilon^2\frac{p}{\mathrm{R}}$$

$$\left[\left(\frac{\delta \phi}{\delta x}\right)^2+\left(\frac{\delta \phi}{\delta y}\right)^2+\left(\frac{\delta \phi}{\delta z}\right)^2\right]+\varepsilon p\,\Delta\phi\Big\}\;u\,d\,\tau\,.\,d\,t.$$

This finally gives for the entire heat produced in the time, $d\,t$, in the space, $\delta\,\tau$, the expression:

$$\Big\{\mathrm{R}\,\Delta\,(\mathrm{U}+\mathrm{v})+2\,\varepsilon\left[\frac{\delta \phi}{\delta x}\,\frac{\delta\,\mathrm{U}-\mathrm{v}}{\delta x}+\frac{\delta \phi}{\delta y}\frac{\delta\,(\mathrm{U}-\mathrm{v})}{\delta y}\right.$$

$$\left.+\frac{\delta \phi}{\delta z}\frac{\delta\,(\mathrm{U}-\mathrm{v})}{\delta z}\right]+\frac{\varepsilon^2}{\mathrm{R}}\,(\mathrm{U}+\mathrm{v})\left[\left(\frac{\delta \phi}{\delta x}\right)^2+\left(\frac{\delta \phi}{\delta y}\right)^2+\right.$$

$$\left.\left(\frac{\delta \phi}{\delta z}\right)^2\right]+\varepsilon\,(\mathrm{U}-\mathrm{v})\,\Delta\,\phi\Big\}\,d\,\tau\,.\,\delta\,t.$$

In order to find the heat, W, produced in a finite space we have to integrate all the elements of $d\,\tau$ of the space. The spacial integral thus obtained is transferred with regard to equation (9), completely into the following integral of surfaces to extend over all the elements, $d\,\sigma$, of the surface of the space with the internal normal ν:

$$\mathrm{W}=-\,d\,t\,.\int d\,\sigma\left[\mathrm{R}\,\frac{\delta\,(\mathrm{U}+\mathrm{v})}{\delta\,\nu}+\varepsilon\,(\mathrm{U}-\mathrm{v})\,\frac{\delta \phi}{\delta\,\nu}\right.$$

$$\left.+\frac{\varepsilon\,\phi\,\delta\,(\mathrm{U}-\mathrm{v})}{\delta\,\nu}+\frac{\varepsilon^2}{\mathrm{R}}\,\phi\,(\mathrm{U}+\mathrm{v})\,\frac{\delta \phi}{\delta\,\nu}\right]$$

Instead of this we may unite more simply, according to equations (2) and (3):

$$W = d\,t\,.\int d\,\sigma\,.\,(R\,N\,\nu + \phi\,J\,\nu)$$

The meaning of this expression will be discussed in the next paragraph.

(*To be continued.*)

COMMUNICATIONS FROM ITALY.

[FROM A CORRESPONDENT.]

SOME time ago I gave an account in your journal of a central station which had been erected at Alzanno Maggiore for the simultaneous supply of power and light. Two weeks ago the first alternating current motor was set in successful action, in presence of numerous specialists and manufacturers. A 5 horse-power motor was installed for working a centrifugal pump, and it acted in so satisfactory a manner that a considerable number of industrialists entered into negociations with the Milan Edison Company for the supply and erection of such motors.

The Italian papers recognise this success as an event of importance, since it solves the problem of the utilisation of those considerable water powers in which Italy abounds and which will serve both for lighting towns, and for supplying power to manufacturers. It will be especially serviceable to the smaller industrialists. The alternating current motor now in action at Alzanno Maggiore is introduced within the secondary net and of course within the low tension circuit branching off from the transformer. It works, consequently, with the same tension as that of the lamp circuit.

At Venice, where the Italian Edison Company is at present erecting a larger alternating current central station (with, for the present, two machines of the type A6, of jointly 160,000 watts), there is already such a warm participation among the shareholders who obtain light from these electric works, that in order to meet the demand the installation of a third machine becomes necessary.

At Vittaio (in the province of Venice) electric works are being erected by the Milan Edison Company for lighting the town. Here also the system of alternating current transformers is being applied.

At Terni there has lately happened at the local electric lighting works a most lamentable misfortune under very peculiar circumstances. A workman of the Societa di Illuminazione Elettrica was in the lower story of an installation which works with high tension continuous currents, and he was engaged in placing the switch so as to make a communication with the main lead. At the moment when the current entered, the workman suddenly uttered a violent shriek and fell on the ground as if struck by lightning. At the outcry of his assistant several persons hastened to his aid, but it was too late, and the physician, who was at once called in, could merely certify his death.

This calamity, by which the company loses one of its most efficient workmen, is the more surprising as the victim was very well acquainted with the manipulation of all the apparatus. The switch was enclosed in a box of which only the man in question had the key. The calamity is probably due to the circumstance that the man, in too great confidence in his own experience, neglected the necessary precaution. It was proved that he had touched the metal button of the switch at the moment of the introduction of the high-tension current.

A Telegraphist Attempts Suicide.—On Monday last, at the Guildford County Police Court, George William Watkins, a telegraphist, was committed for trial for attempting to cut his throat.

THE MANAGEMENT OF ACCUMULATORS.

By J. K. PUMPELLY.*

TO those who wish to handle accumulators, to form them properly, and to charge and discharge them for every day practical use, the writer, who has learned what he knows by hard experience and many disappointments, will, in this article, give some idea of what the work is, and what it must be.

Let us put aside all theories, only understanding enough to make what we do successful. In the first place, we must take it for granted that the care and advantages of location, and a certain amount of scientific knowledge, can produce from a laboratory test with a storage battery more favourable results and a greater per cent. of efficiency than could probably be obtained from the everyday work to which most accumulators are subjected.

Having a number of plates made for the purpose, the process of setting them up for charging and forming is simple enough. It is taken for granted that some knowledge of the make-up of a storage battery is known to those who may be interested in this article, hence we will speak of a storage battery as a collection of lead plates or grids, coated over or filled in with oxide of lead, such as common red lead and litharge; the litharge, which is a slightly different oxide, chemically, than the red lead, is generally used as the negative plate in the battery, and red lead as the positive. These plates are placed in a cell or case, composed of some material that will resist the corroding and disintegrating action of strong acids, facing each other, and never over a quarter of an inch apart, the reason for which will be given later on. Then one less than one-half of the number are connected by means of conducting material, such as lead or copper, well insulated and protected from the action of acid fumes, as the positive plates and the remaining plates, connected in the same way, form the negative pole; these plates being carefully placed and so separated from each other by strips of non-conducting material, that no local action can occur.

The electrolyte consists of water and sulphuric acid, generally eight parts of water to one part acid. When the mixture is first made it becomes very hot, hence it should not be made in a glass vessel. The acid must be poured gradually into the water and constantly stirred, not the water into the acid, and the liquid must not be used for several hours or until cool, and is then poured into the cell until it completely surrounds and covers all that portion of the plates which are made to be acted upon, even reaching above that point an inch.

The batteries being thus prepared, and supposing we have a number of them arranged for convenience in a row, the negative poles are all connected together, and the positive in the same way. Then, in order to charge them, this negative pole connection is attached to the negative pole of the dynamo, and when the dynamo has reached its full speed, the positive poles are connected in the same way to the positive of the dynamo. This is readily accomplished by the use of a switch. Now, as we are ready, and while the current is passing through the battery, we will give our readers and experimenters some idea of how we are to decide upon the proper current and electromotive force necessary for charging. "How and Why" is learned from actual experience and chemical knowledge.

Accumulators do not store electricity, as we understand the word. We are dealing with what must go for comparative expressions. The change that any sufficient current of electricity passing through and then out of the battery produces in the battery is an electroplating action, and while this electroplating process between the positive and negative plates is going on, an element of energy is being held therein, which, when set free, performs a certain amount of work, and this difference between this energy, used up, to produce the necessary chemical change, and the amount of work we get out of the battery, is called the difference of potential.

* *Electrical World.*

Even this expression, "difference of potential," may be crude, and advanced science may find other expressions and other meanings for the cause of this energy.

A current of electricity of a known quantity, called ampères, driven by a known pressure, called volts, when passed or driven through the electrolyte which surrounds the plates of a storage battery will produce a chemical change in some part of the liquid. Exactly what it does, as far as we know, is to decompose the water, setting free oxygen and hydrogen, of which water is composed. The oxygen always goes to the positive pole or side of the battery, and the hydrogen to the negative. When the oxygen reaches the oxide of lead on the positive plate it changes it from an oxide which contains a small amount of oxygen to one now containing more oxygen; in fact, it makes a peroxide of lead of it, and the hydrogen goes to the negative side of the battery, and is evidently absorbed. At the same time, some oxygen must have been driven out of the litharge, which is a still lower oxide of lead than the red lead, and the actual metallic lead, in minute particles, is left on this plate. This is the electro-plating process spoken of.

Now, while this is done, electricity, or an element of energy which becomes electricity, is seemingly stored in the two sets of plates. Now comes the calculation that is approximately correct, by which we can regulate our dynamo, to give the proper electromotive force, in volts of pressure, and, say, three ampères of current will decompose a certain amount of water, and hydrogen and oxygen set free by this current will change a certain estimated surface of lead oxide. Strangely enough, it is found that the moment these plates are insulated and grouped together in a cell in which the electrolyte is confined, and these individual groups consist of positive and negative plates, each group by themselves in a case or cell, the same pressure or voltage will not be sufficient for all the cells; that would do for one cell, but the same amount of current or ampères will be a measure for them all. Thus it takes a little over two volts of pressure to charge each cell, but the same flow or movement of ampères for one as for all—that is, the pressure in volts is multiplied by the number of cells to be charged, but the current in ampères needed is calculated by the extent of surface of lead oxide to be acted upon in one cell—that is, by the size of the single cell; for instance, $2\frac{3}{10}$th volts will charge a battery of one cell with a current of ten ampères for a certain length of time, according to its size, but a current of $2\frac{3}{10}$th volts will not charge a battery of ten cells; but if the volts are increased—that is, the pressure raised to 23 volts and ten ampères—all the cells will be charged in the same time, providing they are all of a size.

Supposing that a current of two volts and five ampères would set free, in a battery, oxygen and hydrogen enough in one hour to convert one square inch of surface, then, if continued ten hours, it would convert 50 square inches. If our battery plates contained 500 square inches of surface we need not take 100 hours for the process of converting or charging, but use a current of 50 ampères for ten hours. It can now be seen that a battery made up of a certain number of plates, of a certain known size, can be charged with a current large enough to charge in a convenient number of hours. So plates of large surface can be charged with a current of many ampères. Thus, having a dynamo that will give a large current, a large battery can be charged as quickly as a small one using a small current.

To sum up, if a number of plates, each of the same chemical surface, were added together, it would give us an approximate idea of the amount of chemical surface that each plate can be acted upon. If $2\frac{3}{10}$th volts of E.M.F. and 25 ampères will produce a certain amount of chemical change every hour on each plate, and the plates are large enough to endure a change equal to an efficiency of 100 ampères, then this currrent of 25 ampères must be forced through the cells four hours, and if we find, as experience teaches us, that there is a loss of, say, 14 per cent., in counting this stored efficiency, then we must continue the charge somewhat longer.

To form new battery plates, so that they may be most efficient, we find that a 30 hours' charge is necessary to complete the change in the negative plates, and nearly three times as long to produce the proper change in the positive plate. The manner in which this is done will be explained further on.

(*To be continued.*)

HAUBERG'S DYNAMO AND METHOD OF COMPOUNDING.

[A COMMUNICATION.]

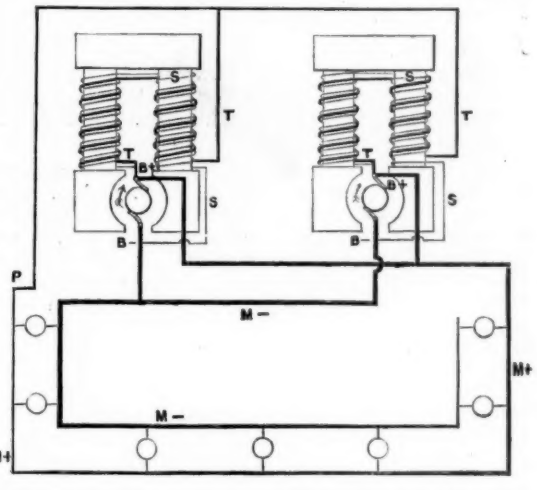
AMONGST the numerous improvements in the construction and making of dynamo machines, the application of cast iron in the field magnets is certainly of importance. It has made it easy to build even very powerful dynamos cheaply by casting in one piece the field magnets and frame, and thus avoiding any division or interruption in the metallic part of the magnetic circuit. The weight of copper on the field magnets is also reduced, although one would think that the larger section of cast iron would increase the length of the windings. However, the more perfect proportions in the well-constructed dynamos of the latest date explain this.

The figs. show a dynamo constructed by Mr. S. C. Hauberg (Messrs. Koefoed and Hauberg, Limited, Copenhagen); it is entirely made of cast iron of selected brands, and is as plain and compact as possible. The field magnet is of the horseshoe shape, cast in one piece with the frame; the wire for exciting the magnet is wound on the vertical part of the magnet. This shape gives the shortest way for the lines of force, and there is no interruption in the magnetic circuit except the space between the pole-shoes and the armature; this allows a very solid construction and an extremely accurate run of the armature without vibration, and with but little distance from iron to iron in the magnetic field. It also enables the winding of the wire to be done on a common turning lathe.

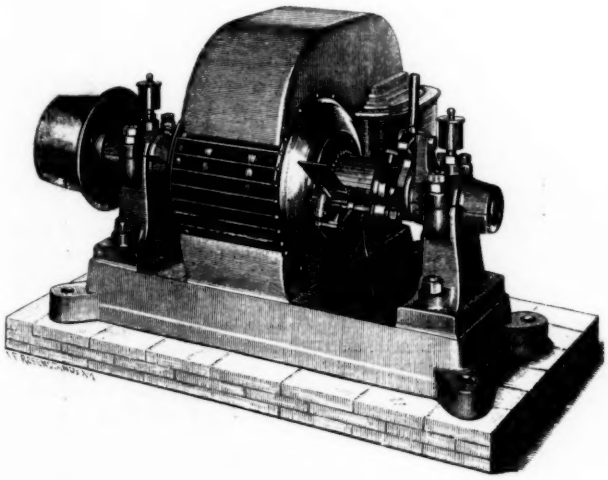
To show how small the weight of copper is on this type of dynamo, we give the following example from a private electric installation in Copenhagen, which required two dynamos, each able to supply the current for 1,000 lamps of 16 C.P. The dynamos are working with 100 volts at the lamps, and give a current of 500 ampères when running at 500 revolutions per minute. The armature has a diameter of $23\frac{1}{2}$ inches, and is $29\frac{1}{2}$ inches long; it is wound as a Gramme ring with 88 copper bars, divided in a suitable manner to avoid any heating through Foucault currents; the copper bars are connected with a commutator divided into 88 parts. The field magnet has a section of 12 inches × $29\frac{1}{2}$ inches, and is wound according to a new system to obtain self-regulation, which is described further down. The weights of copper are:—On the armature, 194 lbs; on the field magnet, 346 lbs; as the dynamo, when working at 500 ampères, has a difference of potential of 115 volts at the brushes, we get 57·7 volt-ampères per lb. of copper on the armature at 100 revolutions, and 20·75 volt-ampères per lb. of total weight of copper on the dynamo at 100 revolutions. The electric efficiency is 96 per cent.; the cooling surface of the machine is very great, and the heating is therefore insignificant.

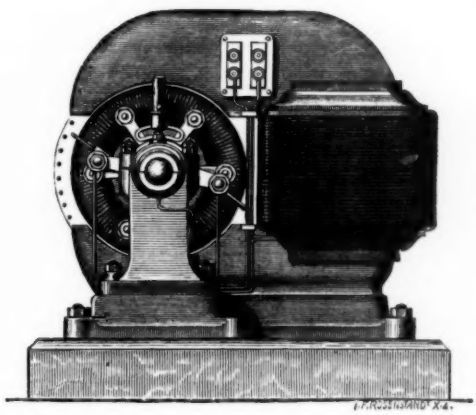
The above-mentioned new system of self-regulation is invented by Mr. F. V. Schioedet, electrical engineer to Messrs. Koefoed and Hauberg, and consists of the following arrangement in the winding of the magnet. The purpose of the system is to make it possible to work two or more compound-wound dynamos in parallel circuit without any danger of the one dynamo reversing the magnetism of the other; this is a point of the greatest importance. The new system may be used wherever by one system or another a larger loss of potential is allowed in the main conductors than is

allowable between the different lamps or points wherefrom wires are leading to the lamps. If, for instance, the dynamo is placed, by some reason or other, at a distance from the rooms to be lighted, we may, to save the expense of a very heavy cable, which would give no loss of potential, use a smaller cable and have a higher potential at the dynamos, and then take these compound-wound according to this system. If we have water-power, and the dynamos therefore are placed far away from the lamps, it would be of the greatest importance to have them compound-wound and self-regulating, and yet involving no danger if two or more are working together. We may also apply this new system in such installations, when the main conductors are laid, as invented by Gülcher, in the manner that they form a positive and a negative bend or interrupted ring, both with the one end in connection with a brush of the dynamo and the wires leading to the lamps leaving the said bends at suitable points of the conductors, so that the loss of potential in the positive conductor to such a point of it added to the loss of potential in the negative conductor to the corresponding point is the same for every two points wherefrom wires are leading to the lamps. In the diagram, M + and M − are the two main conductors connected with the brushes of the two dynamos of the said installation. With 500 ampères the loss of potential in the conductors is 15 volts. Now, if we use compound dynamos, working in parallel circuit, we shall not get the same potential at the brushes if we work one dynamo with 500 ampères, as if we run two with 250 ampères each, as the increase of potential is dependent upon the current passing the main wire on the field magnet. If we shift the current from the one dynamo to the other we should also get a lower potential until the whole current was supplied from one dynamo only. This is avoided thus: In a common compound dynamo we have on the field magnet a shunt wire connecting the two brushes, always being passed by nearly the same current, and then we have the main current passing round the magnet in a thick wire; in Mr. Schioedet's system we have the shunt wire in the same way, but instead of the main current he applies a shunt on the main conductor, connecting two points either on the positive or the negative conductor; this main shunt is passed by a current, dependent upon the loss of potential between the points. By this way the increase of potential is only dependent upon the total current in the main conductor, the current in the main shunt being increased by the greater current in the main conductor causing a larger loss of potential; little and large dynamos can be coupled together, their potential being increased simultaneously in proportion to the loss of potential between the two ends of the said main shunt. The diagram will explain it sufficiently. M + and M − are the main conductors, in which we are working with a certain loss of potential. B + and B − are respectively



the positive and negative brushes, with which the shunt windings, S, are in connection. The two positive brushes, B +, are, by the main shunt, T, connected with the point, P, at the farthest away end of the positive main conductor, M +. By a correct calculation of the loss of potential from the brush, B +, and the point, P, and putting a suitable number of windings of the main shunt, T, on the field magnet, this current will just increase the potential at the brushes as the loss of potential requires. It will be quite clear from the diagram that the one dynamo cannot reverse the magnetic poles of the other, as the main shunt and the ordinary shunt both are passed in the same by the current, even if the one dynamo sends its current through the armature of the other.





REVIEWS.

Journal of the Institution of Electrical Engineers. No. 85. London: E. & F. N. Spon, 125, Strand.

The general contents of this number are as follows:—Papers and discussions on: "The Theory of Armamature Reactions in Dynamos and Motors," by J. Swinburne; "Some Points in Dynamo and Motor Design," by W. B. Esson. Original Communications:—The Torpedo Defence of Canton during the Franco-Chinese War in the Years 1884–85. (Abstract of a

Communication by J. A. Betts.) Classified List of Articles relating to Electricity and Magnetism appearing in some of the principal English and Foreign Technical Journals during the Months of January and February, 1890.

*Berechnung Elektrischer Messungen un zahlreichen Beispielen dargestellt.** VON W. R. P. HOBBS. Oberlehrer an der Marine Torpedo Schule zu Portsmouth. Aus dem Englischen übersetzt Von O. Kletzer. Halle : W. Knapp.

This work is a very careful and accurate version of the English treatise of Mr. W. R. P. Hobbs, of the Marine Torpedo School at Portsmouth. The translator has adhered very closely to the original text, making neither additions nor alterations beyond converting the English weights and measures into their metrical equivalents, and giving the German standard of a horse-power (75 kilogrammetre per second) in place of that of Watt (76 kilogrammetre per second) used in this country.

Of course a detailed examination of a translation of a work so widely known and so generally appreciated must be superfluous.

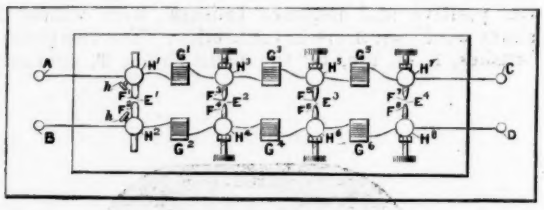


FIG. 2.

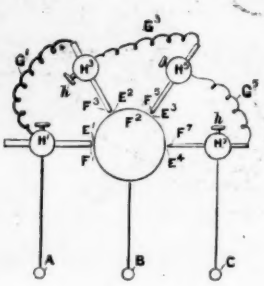


FIG. 3.

L'Année Electrique ou Exposé Annuel des Travaux Scientifiques des Inventions. Par PH. DELAHAYE. Sixième Année. Paris : Baudry et Cie, 15, Rue des Saints-Péres.

This annual continues to serve its useful purpose, and to afford much valuable information to those who have not been able to follow closely or to recollect the subjects given in the technical journals during the year. The volume bears indications of painstaking research, and the various articles from which the matter has been taken have been carefully and accurately condensed. Every branch of electrical science has been referred to, and, altogether, the work does the compiler considerable credit.

OLIVER J. LODGE'S LIGHTNING OR OTHER HIGH TENSION CURRENT PROTECTORS.

THE invention consists of a number of air-gaps, connected to each other by coils or lengths of wire or other conductors, solid or liquid, which oppose the current either by self-induction or electro-magnetic inertia, or by resistance proper, and of either adjustable or fixed width. The apparatus to be protected, whether it be lamps or telephones, or telegraphic instruments or galvanometers, or meters or any other kind of electrical apparatus, is connected to the last air-gap of the series ;

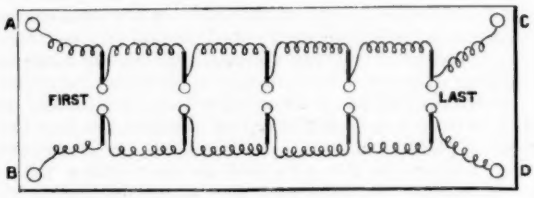


FIG. 1.

the line wire, or exposed leads or other wires, into which it is feared that lightning or high tension currents may possibly come, are connected to the first air-gap of the series.

Fig. 1 shows the general arrangement of the inven-

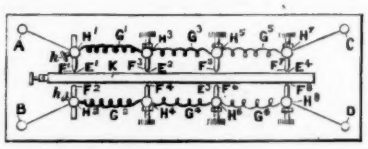


FIG. 4.

tion, and figs. 2, 3, 4, and 5 the practical method of applying the same.

In fig. 1, A, B, are the terminals to be inserted in the leads, or between line wire and earth, &c. C, D, are the

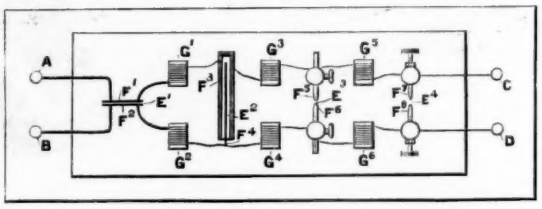


FIG. 5.

terminals to be connected to the instrument or thing requiring protection.

In fig. 2, A and B are the terminals inserted in the leads, or A is connected with the line wire and B with earth ; C, D, are terminals connected with the instrument to be protected, or C with the instrument and D with the earth, or C with the instrument and D left insulated as desired. E^1, E^2, &c., are air-gaps or insulating spaces. These can be formed with one or more points or rounded ends, as shown ; or with knobs or plates or vacuum tubes or other suitable devices ; G^1, G^3, &c., are self-induction coils, consisting, for instance, of gutta-percha covered wire coiled up on bobbins.

The action of the arrangement is as follows :—

The ordinary currents, which it is intended to transmit through the apparatus to be protected, traverse the connecting wires or self-induction coils, G^1, G^3, &c., and do not jump any of the air-gaps. But lightning, or any other foreign and violent currents which may accidentally have got into the leads, will jump one or more of the series of air-gaps, and be thus diverted from the instruments or lamps to be protected.

Thus, the insulating spaces or air-gaps may be

* Calculation of electrical measurements illustrated by numerous examples.

arranged so that the greater portion of a violent discharge will jump the first, E^1; a certain fraction, say a tenth of the remainder, will jump the second, E^2; another fraction, say a tenth of this again, will jump the third, E^3, and so on; the amount finally permitted to go through the protected instrument being thus reduced to any desired amount.

It may be well to set the air-gaps or insulating spaces of different widths; for instance, the first having broad rounded ends wider apart than the second, exposing larger surface and capable of easy examination and replacement (as by binding screw, *h*) in case of damage by a flash; the second having small rounded ends or points close together, and capable of minute adjustment by screwing up as shown (with lock-nuts), or equivalent device; the third still closer and finer, &c. It may also be well to vary the connecting coils, using thicker and more highly-insulated wire for the earlier coils, and thinner for the later, as shown.

Fig. 3 shows a variation useful for protecting the insulation of covered wires or cables in which the exposed line is attached to terminal A, and the protected one to C. B is connected to earth.

The first, F^1, is preferably a knob, plate, or rounded end, as shown, and of stout conducting material, the second and subsequent ones, F^3, F^5, &c., can be knobs or points, preferably the latter, and can be adjusted nearer the central knob F^2 than F^1 is.

In fig. 4, A is connected to the up-line wire, B to the down-line wire, C and D to all the instruments in the station, and E to the earth.

The conductor, K, connected with the earth, is placed between the entrance and exit wires, each of which is provided with a series of knobs, plates, or points (with self-induction coils between) forming air-gaps with this conductor.

Fig. 5 shows an arrangement whereby existing protectors can be coupled up with resistances and other protectors in accordance with the invention. F and F^1 are the ordinary plate lightning protectors; F^3 and 4^4 the well known tubular lightning protector, in which a rod, F^4, is closely surrounded, but insulated from a cylinder, F^3, the one being on one line, the other on the other line. Either the rod or the cylinder is usually studded with points almost, but not actually, in contact with the other, being separated therefrom by a thin stratum of air, a film of mica, or of other insulating material. F^5, F^6, and F^7, F^8, are lightning protecting devices, on the same plan as those in fig. 2.

It may be added that in his patent specification for the protectors, Mr. Lodge makes the following claims:—

1. The method of protecting instruments or other electrical appliances from lightning or other high-tensional currents, such, for instance, as may be received from electric lightning leads, which consists in placing a series of two or more air-gaps or other insulating spaces between the protected apparatus and the main line, whereby, after the first air-gap has shunted most of the high tension electricity, the second shunts most of the remainder, and so on, substantially as described.

2. The method of protecting from lightning and high tension electricity generally, which consists in offering self-induction obstruction on the one hand, and dielectric weakness on the other, to the lightning; and air-resistance obstruction, on the one hand, and thick wire conduction on the other, to the useful current; each offer being repeated several times, substantially as described.

3. The apparatus for protecting instruments and line wires from lightning or other high-tensional electricity, which consists in a series of narrow air or other insulating gaps on the line wire with coiled resistances or impedances between, substantially as described.

4. The addition to an existing lightning protecting device on the air-gap principle of one or more extra devices of the like nature joined up "in parallel" with it, whereby the residual high tension electric fluid not taken off by the original device is in great part shunted by the second, and the residue of the remainder in great part by the third, and so on.

THE WALKER ELECTRIC METER.

THE American exchanges all give a full description of this instrument. The meter belongs to the class of electrical measuring apparatus which furnish a record of the ampère-hours, not directly, but in a form fitted for rapid computation. It is, as will be seen from figure (1), which gives a view of the interior of the meter, a practical modification of an old and much esteemed laboratory device, the photographic registration of galvanometer reflections. Photography has long been used for self-recording instruments, particularly those designed for furnishing continuous records of magnetic and electric disturbances connected with the earth, and its use has been universally successful. As usually set up, however, the apparatus has been of a rather complicated character. The Walker meter has simply taken this well-established method and simplified it for every day use in electrical industry.

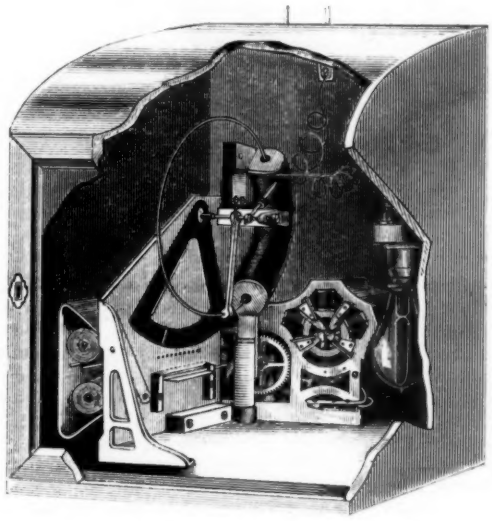


FIG. 1.

The three essential parts of the apparatus are the ammeter, the source of light, and the sensitive film crawling forward at a regular rate to receive the varying indications of the ammeter.

In the instrument as actually made, the ammeter is of the well-known class in which a curved solenoid is provided with a curved core of small iron wire, so small as to be practically saturated by a very moderate current. In this particular case the customary pointer attached to the movable core is replaced by a sector, made in this case from blackened aluminum, and provided with a narrow slot through which the light passes and registers its position upon the sensitive film. The movable core is extended so as to form the larger part of a circle, so that when very small currents are passing, the core is within both ends of the solenoid. By this device it is possible to make the deflection very closely proportional to the current, so that the ampère scale is a scale of equal parts. The lines indicating the ampères are formed upon the sensitive film by the light gleaming through the series of small holes seen in the figure, which replaces the scale of ordinary ammeters. Each hour the shutter shown below this line of small holes is dropped long enough to register an hour line across the film, and thus the film, when developed, shows two series of equi-distant parallel lines, one of them showing the ampères, the other showing the time, and over this diagram appears the registration line showing the exact amount of current that has passed. The roll of paper is moved regularly forward by the clockwork shown in the background of the figure. On the front of this clockwork appears a little electro-

motor which each hour is switched into circuit in series with the incandescent lamp within the meter, and the clockwork is thus kept constantly wound to the same point, insuring a regular rate of movement of the film. This rate of movement can be varied within wide limits so as to adapt the meter to all classes of work.

The incandescent lamp within the meter which furnishes light for the registration is of 8 C.P., and is in series with a variable resistance, so that the amount of light can be accurately regulated.

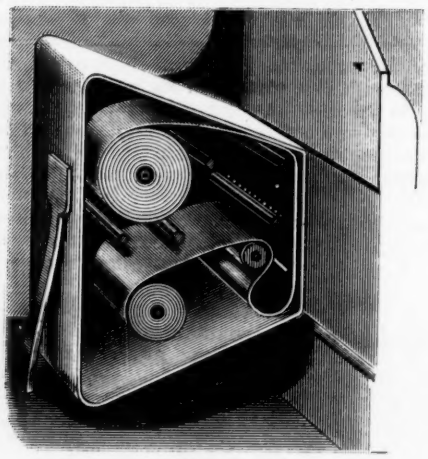


FIG. 2.

The film box, which is shown more in detail in fig. 2, ordinarily contains a roll of sensitised paper sufficient for a month's registration of the current. At the end of the month the meters are visited by the inspectors like so many gas meters, but, instead of the current consumption being read directly, the films are replaced, and those containing the record taken to the office for computation. Inasmuch as both the hour and the ampère scale are scales of equal parts, the area traced out by the ampère line registered is a correct measure of the ampère-hours, and the actual amount of current used can be obtained by measuring this area and multiplying it by a constant, or still better, by running over the area with a planimeter so constructed to include the constant of the meter and give the ampère-hours directly. By this latter process the computation of the various amounts registered becomes very simple and can be done with great rapidity.

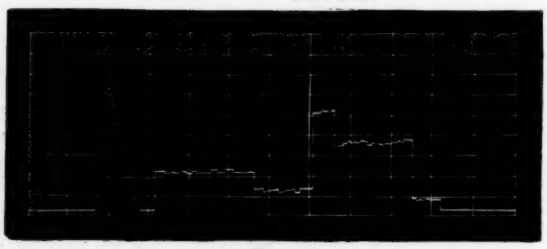


FIG. 3.

In fig. 3 is shown an excellent illustration of the form in which the record appears upon the sensitive film. In the diagram the vertical lines are the hour lines, and the horizontal lines the ampères, while the record appears wandering up and down in the diagram. This record was made specially to show the capability of the meter, and is vastly more irregular than any practical record would be. The dotted lines shown, for instance, were produced by turning out the lamps, one by one, at a rate slow enough to allow each one to register its presence clearly. It is evident from the form of the record that the meter works closely, and is sensitive enough for all practical requirements. Any variation in voltage shows itself in the sinuosities in the ampère line registered. The record taken on this machine will not only give the amount of current used and the time of service, but is a very sensitive detector of any bad administration at the generating station, and any difficulty or carelessness there can be located within a few minutes of the time at which it occurred, when the records are taken to the office to be examined.

One important advantage of this type of meter is that the whole amount of current passing into the house is registered in the meter, instead of a known fractional part being diverted and measured, as is frequently the case in electric meters; consequently the energy lost in the meter is very nearly a constant quantity, the current required to operate the meter by means of a single lamp shown being less than the tenth of an ampère. Aside from this constant loss the only other is that due to the heating of the solenoid, which may be made very small.

The errors of this instrument are only those which may be found in any well-constructed ammeter, plus the possible error that may occur from a variation in the rate of the clockwork. By the method of winding adopted these variations may be made very small. In many of the meters now in use a considerable error may be produced from the fact that an error of the instrument is multiplied by quite a large factor. With a very small amount of current passing, the consumption of energy in this meter is probably equal to or greater than that found in the other well-known types; as the amount of current passing increases, the proportion of loss becomes more and more in favour of the photographic meter.

There seems to be no reason why an instrument of this kind cannot be made thoroughly practical. A careful test of the correctness of the meter has been made by Mr. Geo. B. Prescott, jun., and the result of his test showed, as might have been anticipated from the construction of the instrument, that the record of ampères would not vary perceptibly from that given by a good standard ammeter. As the instrument is nearly frictionless, and as no strain is put on the working parts, it should be easy enough to make it thoroughly reliable. It should be noted that the instrument is very nearly dead-beat, so that on the current being changed the needle takes up its new position with very slight vibration, little or no record of which appears on the sensitised film. Of course the final test of the adaptability of any meter to practical use is putting it in operation on a large scale, but the instrument we are discussing seems to be accurate and practical, and unless experience should show that some part of the mechanism is unreliable, it certainly seems to be admirably adapted to the uses to which an electrometer is ordinarily put. It can readily be fitted for use with an alternating current, although the type at present made is suited for continuous currents only.

DOES CURRENT BETWEEN WHEEL AND RAIL INCREASE TRACTION?*

By O. T. CROSBY.

WE have not infrequently seen in print and heard in conversation the statement that in electric railways, working on a grounded circuit, there is an increase in the adhesion coefficient over that obtained in steam propulsion, due to the passage of the current through the wheels. To obtain some light on this subject the following experiments were made:—

The car used was fitted with two motors of the second type made by the Sprague company. Its total weight was 10,900 lbs. The rail was of the tram type, and, though rusty, was reasonably free from dirt. The wheels showed tires in ordinary service condition. In such case the ordinary coefficients would show a possible tractive effort, before skidding, of 2,500 to 3,500 pounds. As this would have required currents greater than I cared to use, and would, moreover, have exceeded the capacity of the dynamometer at hand, it

* New York *Electrical Engineer*.

was determined to skid only one pair of wheels, and to relieve these of a part of their weight. One end of the car was, therefore, jacked up until the springs were almost, or wholly, relieved. This made it impossible to get dynamometer and current readings simultaneously, as had been desired. However, the ammeter and dynamometer were separately compared.

The currents necessary to produce skidding were first observed when the ordinary connection to ground, *i.e.*, through the metal of the motors, truck, wheels and rail, was in position. The connection was then changed, the ground wire being taken directly to the rail, at a point near the grounded terminal of the dynamo. The wheels were thus out of circuit.

As the first position to which the controlling switch can be thrown admits a current of about 50 ampères (one motor in circuit), a graduated resistance was improvised by putting a soldering iron and a tin plate in circuit; these were approached to, or separated from, each other through a tub of water, in the bottom of which lay the tin plate.

The control thus obtained was somewhat irregular, but answered the purpose. The current could be taken up quite regularly from 0 to about 20 ampères; from that value it frequently jumped to about 42 ampères. In such case the wheels always started to skid, whether ground was made through the wheels or directly to rail. When the current could be made to approach 42 ampères through a better gradation, as with intermediate values of 30, 34, 36 ampères, the skidding did not occur until a higher reading was reached—up to 50 ampères. When the jump was considerable, skidding occurred at even lower values than 42 ampères, as is shown in the accompanying table:—

Wheels in Circuit.

(1.)	Current.—0	12	16	37...	Here wheels skidded.	
(2.)	„ 0	12	14	37...	„	„
(3.)	„ 0	14	16	40...	„	„
(4.)	„ 0	12	16	42...	„	„
(5.)	„ 0	10	12	42 ..	„	„
(6.)	„ 0	25	16	40...	„	„

Similar records, up to 12 in number were obtained.

Wheels out of Circuit.

(1.)	Current.—0	12	31	16	42...	Here wheels skidded.	
(2.)	„ 0	14	16	18	42...	„	„
(3.)	„ 0	15	34	40	39...	„	did not skid.
(4.)	„ 0	15	42	40	35...	„	„

In the last case (4) the rise from 15 ampères to 42 was not as sudden as indicated in the table, though too quick for the recorder to get clear differences. A number of similar trials was made, to the number of fifteen or twenty. In one case of gradual approach up to 40 ampères, without movement of wheels, the controlling switch was thrown into a position giving less resistance in the field; the current rose to 52 ampères, and the skidding began quite vigorously. The change in position of the switch, the current values being such as are here considered, has little effect on the strength of field produced by the three field coils, the arrangement of which is changed by the switch movement; saturation having been reached for any arrangement produced by the switch, at lower currents than the effective values, as shown above.

While the sudden current changes might conceal the particular value just sufficient to produce skidding, the existence of the values, 34 and 25 in the tables above, shows that 37 ampères is about the lowest value, if approached with some gradation, that could produce skidding. This is further shown by this record:—

Wheels out of Circuit.

Current.—0	10	15	23	24	25...	No skidding.
„ 0	12	15	22	20	23...	„

A general conclusion may be stated—that, while the test was not delicate enough to prove that *absolutely no difference* of adhesion exists in the two cases, yet the difference, if it exists, is not worth considering.

Aside from this test, I may say that with nearly the whole of the experience of the Sprague company to refer to, I can recall nothing which refutes the conclusion here drawn. Furthermore, it is to be remembered that up to date the double metallic systems have climbed as steep grades as the grounded systems. In making these experiments it was noted that the slack of the gearing was taken up at from 5 to 10 ampères. When freed from the supporting chocks, the car started at from 10 to 20 ampères, the needle moving so quickly as to prevent accurate reading. When started by man power, exerted through a dynamometer, the record shows 175 to 210 lbs. pull, varying with slight irregularities in the track (called level, but varying slightly in grade and condition of surface).

Correspondingly, when the car was held fast by a chain, the dynamometer in the line of pull, a steady current of 14 ampères through the motor produced a reading of 175 lbs. on the dynamometer, showing the true starting current to have been about 15 ampères. As this occurred when the current passed through the wheels, it again shows that there is no appreciable resistance to wheel movement, either as to skidding or rolling on the rail, produced by the passage of the current.

It is to be remembered that the momentary starting current, as shown by an ammeter, is a function, not only of the actual torsional effect required in the motor, but of the total resistance which it has pleased the manufacturers to insert in the motor circuit. Unless controlled, as was here the case, this initial current may, therefore, be greater than *just enough* to start the car.

The writer is indebted to Mr. Offut, superintendent of the Brooklyn and Jamaica Electric Railway, for the use of a car in making these trials.

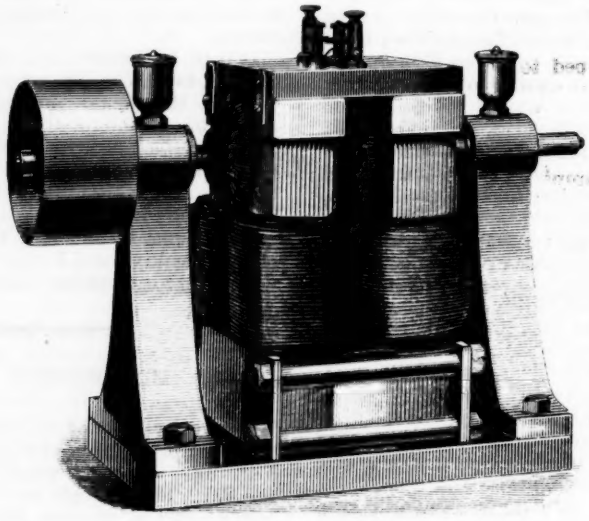
EDINBURGH EXHIBITION.

THE worthy hosts of the palatial hotels of Edinburgh are anticipating that the approaching season will be a very busy one. So much interest has been taken in the Forth Bridge, that ever since its construction was commenced a steadily increasing service of coaches has become established for the conveyance of passengers from Princes Street to Queen's Ferry. This traffic is expected to culminate this year, and arrangements are already made for 56 runs per day of these coaches or, as they would be called on the South Coast, charabancs. This represents a provision for about 3,000 visitors per day in addition to the many others who will find their way to the bridge by private conveyances, by rail, by boat or on foot. Foreseeing what an attraction the Forth Bridge would be during this summer, the first of its being open for passenger traffic, a few Edinburgh gentlemen conceived during the early months of last year the idea of holding an exhibition which should at the same time illustrate the progress of electrical science and commemorate the completion of the greatest engineering achievement of the age. The Town Council were approached for permission to hold an exhibition in the East Meadows (the last Edinburgh exhibition having been in the same locality), but this was not granted, although at the same meeting the Council showed its hearty sympathy with the movement by subscribing £1,000 to the guarantee fund. By September a suitable site was secured at Merchiston and a prospectus issued, the Glasgow Town Council about the same time subscribing £500 to the guarantee fund on the ground that the exhibition was calculated to be practically useful to the whole of Scotland. In October, the guarantee fund having reached £22,000, the Executive Council was authorised to carry out the exhibition, and from that time on to the present, the scheme has been developed and carried on with Scottish perseverance and thoroughness, so that probably no undertaking of a like character ever opened its doors with better assurance of a conspicuous success. Instead of being, as at first

proposed, simply an electrical exhibition, its full title developed into the International Exhibition of Electrical Engineering, General Inventions and Industries, and to meet the increasing popular demand for outdoor attractions provision has been made to introduce features of a sporting character outside even this comprehensive title. The site of the exhibition is on the western outskirt of the city, pleasantly situated between Corstorphine Hill on the north and Craiglockart Hill on the south. Though somewhat distant from the centre of the city the means of communication are ample. The exhibition ground is divided into two almost equal portions by the Suburban Railway of the North British Company, while the Caledonian Company's main line from Glasgow to Edinburgh forms a boundary to the ground on the north, and sidings have been laid down, enabling heavy exhibits to be delivered into position in the buildings. The tramway cars set down passengers at the main entrance as will also the electric boats which are to ply upon the adjoining canal. The buildings alone cover about 15 acres and are constructed almost entirely of wood with galvanised iron roofs. The main building, containing the British and the Foreign Courts, is 700 feet long and 300 feet broad, and the machinery hall, of which the central portion is occupied by the dynamo court, is 750 feet long and 150 feet in breadth. In addition to these two principal erections, there are buildings to be occupied respectively as music hall, 200 feet by 100 feet, art galleries, 160 feet by 90 feet, artistic furniture gallery, 300 feet by 100 feet, and other smaller annexes. The grounds are being laid out with shrubs and flowers and a programme is being arranged for music, illuminations, foot races, bicycle competitions, football matches and, no doubt, Highland games, which will, doubtless, be better appreciated in the northern capital than they were at Paris. A practical turn, at the same time, is to be given to the scheme by the organisation of a course of lectures, explanatory of the principles, construction, and object of the chief exhibits, and there will also be special meetings of the Institute of Electrical Engineers and other scientific bodies. The exhibition opens on the 1st of May. The Duchess of Fife was at first invited to perform the ceremony of opening, but was unable to respond, and it is now arranged that the Duke of Edinburgh, accompanied by the Duchess, will open the exhibition at 1 o'clock on the day named. If not actually settled, it is confidently anticipated, that sometime before its close a visit will be paid to the exhibition by the Queen, and the Lord Mayor of London, who is the president of the London Committee and has taken a great interest in the movement, pays an official visit to the exhibition on the 19th of June, accompanied by the Sheriffs and Town Clerk, on which occasion the civic party will be the guests of the Lord Provost of Edinburgh. The Marquis of Lothian, Her Majesty's secretary for Scotland, is president, Mr. Lee Bapty, general manager, Mr. G. E. Watson, secretary, and Mr. W. A. Bryson, engineer and electrician.

KENNEDY'S ALTERNATING ELECTRO-MOTOR.

THE cut below is a sketch of Mr. Rankin Kennedy's new alternating electro-motor. It consists of two ordinary dynamos, ring or drum armatures (drum armatures in drawing), and laminated field magnets; both armatures are on the same shaft, their coils being connected together. One of the machines acts as the motor, the other takes the place of the commutor; there are no brushes and no commutator, therefore no possibility of sparking.



KENNEDY'S ALTERNATING ELECTRO-MOTOR.

It requires two currents, one at a quarter of an alternation $\sim$ in advance of the other, but it does not require any synchronising, and it can start with load on from rest; the two currents at different phases are obtained from a transformer or two line wires with a third for a common return, or from a coil wound on the field of one of the combined machines. Larger machines are made multipolar.

City and Guilds of London Institute.—The following course of summer lectures will be given by Prof. Ayrton at Exhibition Road, S.W., on Mondays and Wednesdays from 4 to 5 p.m., commencing April 30th:—"The Laws of Self and Mutual Induction and their Application to Alternate Current Circuits, and to Circuits with Fluctuating Currents;" "Practical Methods of Measuring Coefficients of Induction;" "Practical use of Accumulators and Transformers in Electric Distribution;" "Transformers, Direct Current, Alternate Current, Testing, Power, Efficiency;" "The Absolute Systems of Electrical and Magnetic Units—the True and so-called Legal Practical Units;" "The Construction, Laying, and Testing of Submarine Cables;" "The Determination of the Position of Faults in Land Lines and Cables, Simplex, Duplex, Quadruplex and Multiplex Signalling on Land Lines;" "Combined Telegraph and Telephone Systems;" "Simplex and Duplex Signalling through Cables." The lectures are open to outside persons who are not students of the College.

NOTES.

Theatre Lighting.—The new Théâtre Municipal at Tours is lit concurrently by gas and electricity.

Gas Lighting in Persia.—The Persian Ambassador at Berlin has orders from the Shah to send gas engineers, workmen, &c., to Teheran, with a view to the introduction of gas lighting in the towns of the Empire.

Coatbridge and the Electric Light. — The Town Council has resolved to consent to the Electric House-to-House Company applying for a provisional order for the electric lighting of the burgh.

Lighting at Berlin.—The works for the lighting of the Hotel de Ville, which are being carried out by Messrs. Siemens (late Siemens and Halske), will be completed before July next.

The Electric Light at Mauch Chunk.—The capital of the American Alps has just been provided with an electric light plant. The inhabitants of the "Switzerland" were quite elated over the innovation. The system used is the Westinghouse.

The Lighting of Salonica.—The canalisation works undertaken by the Société Ottomane for the lighting of Salonica by gas are now complete.

Electric Lighting at Plymouth.—The Town Council has granted consent to the Devon and Cornwall Electric Supply Company, Limited, for the lighting of the town by electricity.

Ipswich Theatre Lighting.—A theatre is about to be erected in Ipswich under the patronage of Lord Gwydyr, Lord Elcho, Sir Charles Dalrymple, and other well-known friends of the stage. We are reminded, says a morning paper, that in the old theatre of this town David Garrick made his first appearance; here, also, Mrs. Keely, then Miss Goward, a native of Ipswich, began her dramatic career; and in later years Mr. J. L. Toole made his *debut*. Ipswich has greatly increased in latter years, and has now some 60,000 inhabitants. The new theatre, which will be constructed to hold about 1,000 persons, will be fireproof, lighted by electricity, and isolated from other buildings. The architect is Mr. Walter Emden.

The Electric Lighting of Chelmsford.—In our comments last week upon the electric lighting of Chelmsford, we stated that "if the light should fail Messrs. Crompton & Co. will be liable to a fine of £500." The £500 security was a guarantee that this company should carry out its contract to make the installation complete, and to light up the town with the agreed number of lamps. This having now been done, the only penalties for failures, if any such should occur, are those of 4d. per hour and a halfpenny per hour for arc and incandescent lamps respectively, during such time as the lamps may happen to be out.

Paris Lighting.—The credit of 100,000 francs voted by the Municipal Council for experimental lighting will be applied to the incandescent lighting of the rues Auber and des Halles, and to the arc lighting of the quais Valmy and Jemmapes, the avenue Clichy, and the rue des Apennins.

The Light in France.—First trials with the electrical station recently established at Troyes by the Compagnie Nationale d'Electricité were very successful. The same society has obtained concession of the electric lighting of Nimes, which is shortly to be taken in hand.

The Old Students' Association.——Mr. Reckenzaun will address the meeting on April 30th on electric traction.

Telephonic Extension in Devonshire.—Considerable progress has already been effected by the Western Counties and South Wales Telephone Company in Devonshire, where the advantages of the system appear to be generally appreciated at their real worth. The company have lately announced that in cases of fire, robbery, illness, &c., their call-rooms at Plympton, Ivybridge, Avonwick and surrounding localities will be available to the public at any hour of the night, except Sundays, on payment of the usual toll charges, for the purpose of communicating with the fire brigade, police, or infimaries, or, in the event of great urgency, with any of the subscribers. This liberal concession, which is characteristic of the policy of the company, has given much satisfaction in the districts to which it applies.

The Royal Society.—Yesterday the following papers were read:—Shelford Bidwell, F.R.S., "On the Effect of Tension upon Magnetic Changes of Length in Wires of Iron, Nickel, and Cobalt;" Dr. Hopkinson, F.R.S., "Magnetic Properties of Alloys of Nickel and Iron."

Civil Engineers' Students' Meeting.—This evening a paper will be read on "Some applications of Electricity in Engineering Workshops," by C. Frewen Jenkin, B.A., Stud. Inst. C.E.

The Submarine Telegraphs.—At a recent Parliamentary sitting Mr. Henniker Heaton asked the Postmaster-General whether the purchase of the submarine telegraphs between England and the Continent had resulted in a financial success; and whether he was in a position to give the approximate expenditure and the receipts of this service from the period of purchase up to date. In reply, Mr. Raikes said it was difficult to attach a precise meaning to the words "financial success" as employed by the hon. member, but the result of the acquisition of the submarine cables between this country and the Continent might, on the whole, be described as satisfactory. In view of the approaching International Telegraph Conference it would be contrary to the public interest to make any official statement at present respecting the details of this question.

The Height of Buildings.—The action of the City Council of Minneapolis, U.S.A., in disallowing the issue of licenses for the erection of buildings over 100 feet in height, will, it is said, have a serious effect on the question of electric lighting installations.

A Probable Litigation.—We understand that some lively revelations as to the way of conducting business will be made known in a legal action which will shortly be taken by an electrical company against an electrical manufacturing firm. The former gave out a contract to the latter for electrical apparatus and accessories, and the contract was not completed until some months after the specified time. Then when the plant was finished the contracting firm demanded a larger sum than the contract figure, and would not hand over the plant until the additional money was paid. Moreover, we are informed that the manufacturing firm has endeavoured to oust the inventor from the company so as to take his place, and repudiates his claims as to his invention.

Fatal Accident on an Electric Railway.—Reuter telegraphs:—Budapest, April 21st. A sad accident occurred on the electric railway here yesterday. A woman was knocked down by an approaching train, caught by the wheels, and terribly mangled. A number of people who witnessed the occurrence made an attempt to lynch the engine driver and the guard, and it was only with difficulty that the mounted police rescued them from the violence of the infuriated crowd.

An Extraordinary Piece of Stealing.—Everyone in France is familiar with the story of the priest to whom one of his flock confessed that he was guilty of having stolen the anvil of the big steam hammer at the workshop; the priest, shocked at the enormity of the mischief, earnestly entreated the culprit to effect a prompt restitution of the stolen goods. It has often been said that fact is stranger than fiction, and we have an illustration of this saying in the following story, given by the Paris *Intransigeant*:—"The administration of the 'Théatre des Variétés' was very much surprised to find, about a month ago, that a theft had been perpetrated to their prejudice; the battery of accumulators used for the lighting of the theatre by electricity had been stolen. This battery, composed of 38 accumulators, weighing each 15 kilogrammes (a total weight of 570 kilogs., or over 12 cwts.), had disappeared without anybody's attention having been attracted to the fact. Enquiries instituted by the directors did not lead to any result; the firm of electricians which supplied the apparatus were not more successful in their attempt to elucidate the mystery. The matter was given up and almost forgotten, when the managing director of the theatre received a letter running as follows:—'Sir,—You must have been very much surprised at the disappearance of your electric accumulators. Do not despair; they will be sent back to-day, without any cost for carriage,' *Ce qui fut dit fut fait* for, a few hours later, a car, heavily loaded, stopped in front of the theatre, and the authorities were informed that the 38 accumulators, all in a perfect state, were ready for delivery. The carman, duly questioned, could only say that he met in the street some men, unknown to him, and harnessed to a wheel-barrow containing the apparatus; they engaged in conversation with him, treated him with a few glasses, and induced him to undertake the delivery of the goods at the theatre, paying him a sum of five francs for his trouble. The man did not know anything more about it, and, as our contemporary winds up: '*L'affaire en est là.*'"

The Production of Copper.—The present supplies of copper in England and France stand at 95,000 tons, as against 125,000 tons in March, 1889. A year of very active trade has thus only effected a diminution of 30,000 tons in the public stocks, which are still twice as large as they were when French speculators first turned their attention to the copper market. With regard to consumption, the deliveries in England and France for the year ended February 28th last amounted to 134,000 tons, against only 59,000 tons in the preceding 12 months. In production there was an increase of nearly 4,000 tons. The total production in 1889 was 262,990 tons, as compared with 259,126 tons in 1888, 223,973 tons in 1887, and 217,136 tons in 1886. With the exception of Chili, there was an increase in the supply of copper last year from all the leading sources. Statistics show that at the present range of prices the tendency is for production to increase rather than to diminish. Consumption is expected to do little more than keep pace with supplies, even if it does that.

Electric Tram at Clapham.—Early on Wednesday morning, says the *Echo*, the first electric tramcar for use in London was conveyed to the South London yard by the London Electric Tramcar Syndicate at Clapham. In a few days it will run from Clapham to Tooting. This is the first of six similar cars for use on the South London line. They will run at about the same rate as the horse cars, and are fitted to accommodate 44 passengers each.

A Question of Priority.—The Secretary of the Laing, Wharton and Down Construction Syndicate writes to us claiming for Weybridge, in Surrey, the honour of being "the first town in the country to be lighted throughout by electricity," the installation having been started on March 1st last. It will be remembered that at the inauguration of the Chelmsford public lighting on the 14th inst. that distinction, whatever it may be worth, was claimed for the latter town.

Edison in England.—The *Manchester Courier* says Mr. Edison is expected to be in London in time to take part in the American banquet to Mr. Stanley. He will leave New York in the early part of next week, and will be accompanied by his wife, his private secretary, his chief electrical engineer, and his legal adviser (Mr. Eugene Lewis). Before returning to America the party will make a tour of the principal European capitals, with the view of making arrangements regarding the patent rights of the phonograph in each country. It is reported that in addition to perfected phonographs, Mr. Edison brings with him several other inventions which he will make public in Europe for the first time.

Telephones in Paris.—A little time ago it was rumoured that the central telephonic station of Paris would be installed in the top storey of the "Bourse," but this idea has been abandoned. The exchange will now find a home in an immense pile of buildings which are going to be erected in the rue Gutenberg, just opposite the new General Post Office, rue Jean Jacques Rousseau, and in which it will find ample accommodation. The buildings, the plans of which have already been submitted and approved, are to be three storeys high, and the ground floor is to be utilised for the purpose of housing the Post Office vehicles. On each floor will be fitted a switchboard, on the American style, capable of accommodating from 15,000 to 20,000 subscribers. The new central exchange is expected to be ready for opening by the beginning of 1892.

Is Adelina Patti's Voice Her Own?—Under this heading, a Paris daily newspaper announces that Madame Patti has begun an action at law against a certain American Barnum who, being the proprietor of one of Edison's most recent and perfected phonographs, has successfully "bottled" a few of the *diva's* best songs, and is retailing them through the length and breadth of the States to an admiring . . . . and paying public. Madame Patti naturally complains of this damaging competition, but it rests with the tribunals to decide if an artiste's voice is his or her own, phonographically speaking.

Extension of the Telephone System in the North.—The National Telephone Company have just completed their trunk lines from Inverness to Dingwall and Strathpeffer *viâ* Beauly, and have opened exchanges in Dingwall and Strathpeffer, which now become the most nothern points touched by the telephone exchange system in Great Britain.

A Large Order.—The great increase occasioned by electricity in the demand for certain classes of material is, says an American exchange, well illustrated by the order which has just been placed by a Louisiana electric light company for two driving belts, one of which is to be 160 feet long and 72 inches wide, and the other 48 inches in width, and of much greater length. These will require the hides of more than 600 head of cattle.

Italian Telegraphy.—The Baudot multiple apparatus has been installed on the telegraph lines between Turin, Milan, and Naples.

Speed Indicator Wanted.—"There is," says *Modern Light and Heat*, "an excellent chance for an ingenious inventor to devise a cheap and reliable speed indicator for electric cars."

An Exhibition at Prague.—The inhabitants of Prague recollect the fact that the first industrial exhibition ever held took place at Prague in 1791, in honour of the coronation of the Emperor Leopold as King of Bohemia, and are preparing to celebrate the centenary in a manner to give an idea of the progress which has since been made in industrial arts, fine arts, and science.

Proposed Inspection of Electric Plants by Underwriters.—Chicago underwriters have appointed a committee to consider the feasibility of appointing special inspectors of electrical wires and appliances in buildings upon which they have risks. The *Western Electrician* considers it a complimentary tribute to the construction work of the Chicago electric companies that the necessity of this step has not been felt before, and expresses a doubt that even now anything will be done in the matter.

The Late Joseph Henry Appreciated.—Congress is to be asked to pay the two daughters of the late Professor Joseph Henry $20,000 as part compensation for their father's gratuitous services as a scientist. A number of scientific gentlemen are discussing the question of giving the names of Henry and Franklin, and perhaps some other Americans, to the electrical units which have not yet been definitely named.

Extension of Business.—The United Asbestos Company, Limited, has recently opened an additional branch house at Provident Buildings, Clare Street, Bristol. The company's business is extending, and it has now branch houses in Glasgow, Newcastle-on-Tyne, Manchester, Liverpool, Cardiff, Bristol, Paris and St. Petersburg.

Central London Electric Railway Bill.—The consideration of this scheme for carrying an underground railway from Uxbridge Road to the Bank, at a cost of over three millions sterling, was resumed on Monday before the Select Committee of the House of Commons, under the presidency of Mr. Walter James. Mr. Greathead, the engineer, said that there would be two tunnels 11 feet in width. There would be more accommodation in height and width than in the underground railways. The carriages would be entered from the ends, as in the tramcars, and they would weigh about one-half that of a Metropolitan carriage—that is, 80 tons as against 165 tons. There would be nine stations at intervals of about half a mile, and two termini, and the total capital and borrowing powers would be about three and a quarter millions sterling. There was not the slightest fear of vibration or noise above ground, the average depth from the surface being 50 feet. There would be no blow-holes, as in the Metropolitan railways, where steam was used, and the locomotive engines would be entirely driven by electricity. Dr. Hopkinson, the electrical engineer, said that the cost of generating power and locomotive engines, and other plant, would be about £275,000. It is expected that the enquiry will go on for about a fortnight, nearly the whole of the Parliamentary Bar being engaged.

Electrical Engineering at King's College.—Great efforts are being made by the Council of King's College to meet the growing wants of the age, in the direction of electrical engineering. The engineering department of this College has always had a high reputation, but now, thanks to the munificence of Lady Siemens, a new laboratory for electrical engineering, to perpetuate the name of her distinguished husband, and to be called the "William Siemens Laboratory," is to be constructed and fitted with every modern electrical appliance. Through the kindness of the well-known engineers, Messrs. Davey, Paxman & Co., of Colchester, the council is enabled to equip a fine engine and boiler room with all the machinery requisite to provide the necessary power, and it is hoped that by this means the whole College will ultimately be lighted by electricity. A new chair of electrical engineering has been established, and the first Professor has been appointed—namely, Dr. John Hopkinson, F.R.S., the President of the Institution of Electrical Engineers, than whom no better selection could be made to undertake the direction of such a laboratory. It is hoped that the new arrangements will commence with the October session.

Method of Repairing Short-Circuited Condensers.—J. J. O'Connell, electrician of the Chicago Telephone Company, writes to a contemporary as follows in regard to crossed condensers: "We have been obliged to abandon a considerable number of condensers in telephone work because they became crossed and short-circuited. Lightning, whenever it strikes a condenser, will almost invariably cause a cross. While experimenting recently I ascertained an easy way of removing a cross in a condenser. It consisted simply in passing a current of about 20 ampères through the condenser until the tinfoil was fused at the point where the cross existed. The remedy has proven so effective that a cross never reappears at that point in the condenser again. After I removed crosses from a condenser recently by this means, I endeavoured by the discharge of an induction coil to cause them to return, but found I was unable to do so. A great many crossed condensers might be fixed by this simple remedy, so I present it for the benefit of the readers of the *Western Electrician*. I may say that I used 110-volt Edison current in the experiment."

Insurance Inspectors to be Inspected.—A meeting was recently called of electrical and insurance men, in New York, to complete arrangements for a number of insurance inspectors to be examined and instructed by first-class electrical engineers, so as to be able to determine correctly the quality of all electrical work.

Electrical Communication between Lighthouses and the Shore.—This important subject occupied the attention of the Plymouth branch of the Royal National Lifeboat Institution at its annual meeting last week. The committee reported that, in pursuance of the resolution passed at a special meeting last year, a circular was issued, inviting all the branch committees of the institution to unite with this committee in supporting their memorial to the parent committee, urging the necessity of strong efforts being made to induce the Government to establish a system of telephonic and telegraphic communication between coastguard stations, shore lighthouses, and lifeboat stations on the salient points of the coasts of the United Kingdom, and the telegraph system. Some 188 branch committees had expressed approval of the memorial, and their desire to support it on presentation. The memorial was accordingly presented in February last by Vice-Admiral Hickley, chairman of the branch, and it was very favourably received, the parent committee expressing their entire concurrence with its purpose, and appointing a strong special sub-committee to consider the subject. There was thus much ground for hoping that the question was approaching a satisfactory solution. Vice-Admiral Hickley, who presided, explained that the cost to the nation, if the proposed scheme were undertaken by the Government, would be between £100,000 and £110,000; but when they thought of the enormous capital the country had floating at all times of the year, and the number of souls employed in connection therewith, the importance of electrical communication with the shore, in the event of shipwreck or other accident, was too obvious to be dwelt upon. Considering the great advantages to be derived from this communication, the cost was but trifling. Mr. Bayly said that they should not rest until they had communication round the coasts, such as existed in Denmark.

Modesty and Philanthropy!—"The world owes a debt of gratitude to Mr. Geo. Livesey," says the *Gas World*, and, continues our contemporary, "the Testimonial Committee has succeeded in scraping together for the purpose of discharging the debt—£1,700 after six weeks of circularising and advertising." Now Mr. Livesey does not want a clock, a portrait, or a teapot, having, doubtless, more of these than he needs, so he suggests that the testimonial should take the form of a park for the poor of London. The suggestion shows Mr. Livesey to be as philanthropic as he is modest, since the park would cost something like £20,000.

Electrical Companies Falling Out.—The case which originated in the seizure by the Société Française d'Accumulateurs Electriques of Pollak accumulators made in M. Constant Rousseau's factory, came before the 10th Correctional Court at Paris on the 17th inst., when MM. Bergon, de Parville and Fribourg were appointed experts to report upon the matter on the 29th prox.

NEW COMPANIES REGISTERED.

Venezuela Telephone and Electrical Appliances Company, Limited.—Capital, £70,000, in £1 shares. Objects: To carry on in the Republic of Venezuela the businesses of telephone and telegraph companies, and to act as contractors for the supply of electricity for lighting and other purposes. Signatories: Sir Douglas Fox, Kingston-on-Thames; J. W. Phillips, M.P., 24, Queen Anne's Gate; W. P. van Laar, Paris; Hy. P. Gilbert, 7, Poplar Grove, Shepherd's Bush Road, 250 shares each; Louis Franke, Winchester House, 2,000 shares; D. Antaminson, Amsterdam, 500 shares; J. Simpson, Bushey View, Hampton Wick, 100 shares. The signatories are to appoint the first directors; qualification, £250 in shares; remuneration, £500 per annum, divisible. Registered office, Winchester House, Old Broad Street. Registered 22nd inst. by Ashurst Morris, Crisp, & Co, 6, Old Jewry.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Fowler, Lancaster and Company, Limited.—An agreement of 20th February, filed on the 4th ult., cites that by an agreement of 4th January it was agreed that the company should purchase the business of electrical engineers carried on by Fowler, Lancaster & Co., at the Albert Works, Graham Street, Birmingham, in consideration of the sum of £9,900, whereof £6,000 was to be satisfied by the allotment of 600 fully-paid preferred shares, and £200 by the allotment of 20 fully-paid deferred shares; and that as further part of the consideration the company should issue to the vendors, or their nominees, as fully paid up, one equal sixth part of any share capital hereafter to be created.

Trent Gas Engine Company, Limited (engineers, and electricians).—An agreement of 10th February provides for the purchase of the British and foreign patent rights of Richard Simon, of Nottingham, relating to gas engines. The British patents are Nos. 1,363 of the year 1885, and 16,183 for the year 1888. The purchase consideration is £11,000, payable £500 in cash, £3,000 in fully paid preference shares, and the balance in fully paid ordinary shares. Registered offices, 38, Duke Street, New Basford, Nottingham.

Fareham Electric Light Company, Limited.—The statutory return of this company, made up to the 10th inst., was filed on the 16th inst. The nominal capital is £5,000 in £1 shares; 1,257 shares are taken up, and 10s. per share has been called thereupon. The calls paid amount to £455, and unpaid to £173 10s. Registered office, Wedbury Lodge, West Street, Fareham, Hants.

Archer Pipe Company, Limited.—An agreement of 28th February, filed 6th ult., provides for the purchase by the company of the inventions, the subject of letters patent, Nos. 16,272 of 1886, and 1,198 of 1889, relating to earthenware pipes for carrying water, gas, cables, lines and wires for electric light, telephone, telegraph and other similar purposes. The purchase consideration is £8,000, payable £3,000 in cash, and £5,000 in fully paid shares.

Poole and White, Limited.—An agreement of 19th February (filed 25th February) provides for the purchase by this company of the partnership business of Poole and White, electrical and mechanical engineers, of 58 and 59, Bread Street, E.C. The purchase consideration is £3,460 17s. 10d., payable as to £460 17s. 10d. in cash, and the residue in fully-paid "B" shares.

Railway and Domestic Electric Lighting Company, Limited.—At an extraordinary general meeting of the shareholders in this company, held at 34, Great St. Helen's, on the 21st ult., it was resolved to wind up voluntarily, Mr. Walter Curtis being appointed liquidator. The resolution was confirmed on the 16th inst., and was duly filed on the 21st inst.

Bedford Electric Light Company, Limited.—The annual return of this company, made up to the 14th inst., was filed on the 18th inst. The nominal capital is £15,000, divided into 250 founders' and 14,750 ordinary shares of £1 each. The shares taken up are 882 ordinary and 154 founders'; upon the former 1s. per share has been called, and the full amount upon the latter. The calls paid amount to £197 19s., and unpaid to 3s.

CITY NOTES, REPORTS, MEETINGS, &c.

The Eastern Extension, Australasia, and China Telegraph Company, Limited.

AT the twenty-third ordinary general meeting of the shareholders, held at Winchester House on Wednesday last, Sir John Pender, K.C.M.G., presided, and the report and accounts for the half-year ended December 31st, 1889, were laid before the meeting.

The Chairman presumed the report would be taken as read. He believed he might safely congratulate them upon it, and he hoped they would accept it as satisfactory. Before asking them to approve it he would, as usual, go over some of the paragraphs to give them some idea of what had been done in the past six months. Accordingly, he gave a *resumé* of the report, which will be found printed in the last issue of the ELECTRICAL REVIEW. He then went on to speak of the International Telegraph Conference which is to be held in Paris shortly. These conferences, he said, were held every five years. He had always said that the object of the land lines and of the irresponsible Governments with long purses, with regard to those conferences, was to get tariffs reduced. Of course they gave away nothing out of their own pockets thereby, and it was a very remarkable fact that nearly all the Governments of Europe were actually working the telegraphic system at a loss. He had always found on the part of the representatives of the different Governments of Europe at these conferences a fair desire to meet the cable companies, and to admit that the cable system did its work quicker, and even better, than the land system, and that the cable companies were entitled to something more. But when the cable companies were told that, and also that they were to charge a lower rate, he, the speaker, thought that was a very nice way on the part of those Governments of getting hold of the work themselves. The cable companies were expected not only to do the work better than their rivals did it, but also cheaper. The shareholders would therefore see that it was necessary in their interests that they should be represented at these conferences, and they might depend that their interests would not be neglected, and if their representatives could see their way, by a reduction of the tariff, to increasing the company's traffic for the benefit of the shareholders, they would always be ready to take a broad view of the matter. At the same time he was hopeful that they would not be required to make any special sacrifice. There was a great deal of talk abroad about reduced tariffs, and about what telegraph companies ought to do, but when he saw those statements in the papers he always found that the persons from whom they originated knew nothing about it. As a rule he deprecated answering any statements that appeared in the public press. Fiction made a paper pay better than truth; but when he saw such a statement as that they ought to carry telegrams from England to Australia for a shilling, it rather made him feel that ignorance was being carried too far. It was the tendency of the press and of people to believe anything they thought would cheapen the article for themselves, and it was necessary they should be made to understand by figures that they were either deceived themselves or were deceiving the public. The actual cable distance to Port Darwin, where telegrams were handed over to the Australasian Government, was nearly 12,000 nautical miles. The out-payments alone, without giving any return to the Eastern Extension Company for its enormous system, amounted to four shillings and tenpence. He would be a very clever fellow indeed that could establish a system for a shilling and pay four shillings to other people out of it. Germany, Russia and the Indo-European Company received one and fivepence; Persia received sevenpence; the Persian Gulf Government department elevenpence; India sevenpence halfpenny; Java a penny halfpenny, and Australia one and twopence. Consequently the out-payments were nearly five times as great as the tariff advocated; and, as the Eastern Extension Com-

pany must receive some remuneration for their part of the work, it was obvious that the most elementary part of the questions had not been appreciated. Some two or three years ago, when speaking of this tariff system in connection with the colonies, he stated that if the company could get a Government guarantee it would so very much enhance the value of their property that they would be satisfied with a lower dividend, seeing that it would be a Government-guaranteed dividend; and the directors had since proposed to the Australian Colonies that if they would guarantee the income which the company received at present, they might make the tariff what they pleased. He believed that the question had been very much discussed, and that it was considered a fair proposition by those colonies. But they said that the increase would be so large that the companies ought to take the responsibility themselves. He (the chairman) said no. If the colonies were to take the benefit of the increase, the company was quite prepared to show its belief in it by taking 25 per cent. of the responsibility; but that the other 75 per cent. ought to be taken by the colonies. If the company was to get an increase of cent. per cent., and reduce it to four shillings instead of nine and fourpence, the guarantee of Victoria would amount only to £3,731 per annum; that of New Zealand to £3,727; that of South Australia to £',164; Western Australia's to £147; New Zealand's to £2,192; Queensland's to £1,279, and Tasmania to £510. With those figures before them, and with such an insignificant sum demanded from the colonies, to reduce the company's tariff from nine and fourpence to four shillings would, he thought, be doing their duty to the very fullest extent; and if the colonies were not sufficiently alive to the great benefits which they would derive from the proposed arrangement, he could only say that it was a subject which was more delayed than abandoned. For himself he would not be averse to coming to an understanding with the colonies which would enhance the value of the company's property. He liked cheap telegraphy, but he also liked good security for his shareholders. He begged to move the adoption of the report and accounts as submitted, and to declare a dividend of 2s. 6d. per share, together with a bonus of 4s. per share (both free of income tax), payable on the 24th inst., and making, with the previous distribution, 7 per cent. for the year 1889.

The motion was seconded by Mr. F. A. Bevan, and carried unanimously.

Mr. C. W. Earle and Sir Thomas Fairbairn, Bart., were unanimously re-elected directors, and Messrs. Henry Dever and Welton Jones & Co. were re-appointed auditors at a salary of £100.

The Chairman, replying to a vote of thanks to himself and the directors, said the company certainly was a big concern and was growing bigger almost daily. Its management required some judgment and sometimes good temper. At the same time he had never been more satisfied with the working of their submarine system. He recollected a time when a break in a cable caused him many sleepless nights; he did not lose his sleep now. He looked upon the company as a sound and growing property, and, more than that, as a property that the world and the governments of the world could not for one moment dispense with. It was a great public necessity, and would, he trusted, always be guided and piloted with such a degree of moderation and judgment as that it would command not only the support of its shareholders but the support of the Governments who were watching it very closely, and that of the general telegraphing public.

The Oriental Telephone Company, Limited.

IN the directors' report for the year ending 31st December, 1889, to be presented at the 10th ordinary general meeting of the company, to be held at the City Terminus Hotel, Cannon Street, in the City of London, on Tuesday, the 29th day of April, 1890, at four o'clock p.m., shows that the net profit for the year is £7,119 1s. 11d., after writing off £438 6s. 3d. for exceptional expenses at three of the company's branches. Including the sum of £685 18s. 11d. brought forward from 1888, the amount available for disposal is £7,805 0s. 10d., which the directors recommend should be dealt with as follows:—To place £2,000 to the reserve fund; to transfer £500 in reduction of value of stores at branches; £340 13s. in reduction of amount expended on exchanges on hand, which will then stand at £34,000; and to pay a dividend of 3 per cent., free of income tax, on the paid up capital of the company, other than the vendors' shares, carrying forward £1,237 2s. 8d.

The returns from the Indian companies for the past year show an improvement. The Bengal and Bombay companies have declared dividends of 4½ per cent. and 3 per cent. respectively on their issued capitals.

The Telephone Company of Egypt has declared a dividend of 6 per cent. on its preferred shares, free of income tax, and carries forward £1,459 1s. 4d.

The dividends accruing on the shares held by this company, in the above named companies, have been brought into the accounts as usual.

The exchanges at Rangoon and Singapore continue to expand, but those at Madras, Moulmein, Colombo and Port Louis make but little progress. A change has recently been made in the management at Mauritius, involving some additional initial expense, which it is hoped may result in some improvement at that branch in the early future.

The China and Japan Company has further developed its exchanges at Shanghai and Hong Kong. The accounts for the past year show a surplus of £573 16s. 4d., after paying debenture interest and writing off £300 15s. 10d. in respect of depreciation and preliminary expenses. In order to provide that company with more working capital, your directors have taken up during the current year an additional £500 of its 7 per cent. debentures.

During the early part of last year a circular was issued by the directors to each holder of the vendors' shares asking them to meet the board in reference to a rearrangement of capital account. A meeting was held in response to this circular, but up to the present the negotiations have not resulted in an arrangement.

The directors who retire at the meeting are Mr. W. Addison and Mr. G. B. Frost, both of whom being eligible offer themselves for re-election.

The auditors of the company, Messrs. Deloitte, Dever, Griffiths and Co., also retire, and offer themselves for re-election.

Reuter's Telegram Company, Limited.

THE 26th ordinary general meeting of the shareholders was held at the company's offices, No. 24, Old Jewry, on Wednesday, the Right Hon. Sir John C. D. Hay, Bart., K.C.B., presiding. The report, which appeared in our last issue, having been taken as read:

The Chairman, in moving its adoption, said at their last meeting they had rather poor results to show for the year 1888, owing to causes which were then indicated. The year 1889, though not devoid of important results entailing considerable expense for telegrams, had been comparatively quiet. There had been no little wars to drain the company's coffers without its deriving extra contributions from its subscribers. The quieter state of political affairs had been accompanied by great prosperity in most countries, and the company's revenue had consequently been swelled by extra sources of income. In a business like this it was always unwise to disclose a company's affairs too minutely for the advantage of active competitors, and the directors knew that shareholders always appreciated reticence. They felt bound to warn the shareholders that a check to trade meant a restriction of commercial telegrams and subscriptions, so that the favourable figures presented must not be considered as outside the influence of trade fluctuations, as well as political affairs. For this reason the board had thought it prudent to replace two-thirds of the amount taken from the reserve fund to make up the 5 per cent. dividend in April last year. The reserve then would stand at nearly £12,000, so that the company's financial position was strong. With regard to the negotiations with the company's Continental lines, he was happy to say that, thanks to the company's managing director, who made sundry trips abroad to personally conduct them on behalf of the company, those negotiations had resulted in the conclusion of new agreements for a term of many years; so that whilst the company was thereby fortified against competition of an international character, it preserved absolute independence in its own territories. The same independence was enjoyed by the different international agencies in their respective countries with which the company was connected by working arrangements. In conclusion, he expressed the regret of the board and of the shareholders at the retirement of Mr. Frederick J. Griffiths from the secretaryship, owing to ill health.

The Hon. Mark F. Napier seconded the motion, which was carried *nem con.*

On the motion of the Chairman, seconded by Mr. H. de Reuter, the re-election of the Hon. Mark F. Napier was agreed to; Messrs. Welton, Jones & Co. were re-appointed auditors, and with a vote of thanks to the chair and directors, the meeting broke up.

Great Northern Company of Copenhagen.

THE directors' report just issued shows the traffic receipts, together with balance on the 31st December, 1888, and sundries, amount to £336,552 7s. 7d. Under the head of expenditure, salaries and wages are given at £38,974 10s. 6d.; expenses of stations, offices and agencies, £8,602 8s. 7d.; supervision and maintenance of lines, £12,593 0s. 8d.; instruments and cells, £2,858 6s. 4d.; maintenance of buildings, £443 8s. 5d.; travelling expenses, £691 13s. 5d.; bank commission, &c., £3,654 1s. 3d., and sundries, £428 5s. 11d.; 5 per cent. interest on debentures and amortisation of 350 debentures amounts to £49,250. The remaining sum of £219,055 12s. 6d. is appropriated as follows: Interim dividend on 150,000 shares at 5 per cent. and extra dividend of 2½ per cent., £112,500; addition to reserve fund (which is now £629,347.13s.), £55,555 11s. 1d.; addition to pension fund, £2,777 15s. 7d.; directors fees, £1,500; balance carried forward, £46,722 5s. 10d.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 18th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £4,055

The West India and Panama Telegraph Company. The receipts for the half-month ended April 15th, are £3,593, as compared with £3,742 in the correspondin period of 1889.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (April 17).	Closing Quotation. (April 24.)	Business done during week ending April 24, 1890.	
£					Highest.	Lowest.
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	98 —101	98 —101	99	...
1,549,160	Anglo-American Telegraph, Limited	Stock	48½— 49½xd	49 — 50 xd	49½	...
2,725,420	Do. do. 6 p. c. Preferred	Stock	83 — 84 xd	83½— 84 xd	84¼	83½
2,725,420	Do. do. Deferred	Stock	14 — 14½	14½— 14⅝	14 5/16	14½
24,000	Australasian Electric Light, &c., Limited, Nos. 1 to 24,000 ...	5	... ...	... ...		
130,000	Brazilian Submarine Telegraph, Limited	10	12¼— 12⅝	12½— 12⅝	12½	12 5/16
99,000	Do. do. 5 p. c. Bonds...	100	100 —102	101 —103		
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	104 —107	105 —108	106½	...
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416... ...	3	2¼— 2½	2¼— 2½	2 7/16	2 5/16
63,416	Do. do. Preference, Nos. 1 to 63,416 ...	2	1⅝— 1⅞	1⅝— 1⅞		
224,850	Consolidated Telephone Construction and Maintenance, Ltd. ...	14/-	3/16— 1/4	9/16— 11/16		
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5¼— 5⅝	5¼— 5⅝		
16,900	Cuba Telegraph, Limited	10	11 — 11½	11 — 11½	11¼	...
6,000	Do. do. 10 p. c. Preference	10	17½— 18½	17½— 18½	18⅛	17½
12,931	Direct Spanish Telegraph, Limited ... (£4 only paid)	5	3¾— 4¼	3¾— 4¼		
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10		
60,710	Direct United States Cable, Limited, 1877	20	10 — 10¼xd	10⅛— 10⅜xd	10 5/16	10⅛
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14 — 14⅛xd	14⅛— 14⅜xd	14⅜	14⅛
70,000	Do. 6 p. c. Preference	10	14⅛— 15 xd	14⅜— 15⅛xd	14 11/16	14⅞
200,000	Do. 5 p. c. Debs. (1877 issue), repay. Aug., 1899	100	106 —109	106 —109		
1,200,000	Do. 4 p. c. Mortgage Debenture Stock	Stock	108 —110	109 —111	110	109
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	14¼— 14⅛	14⅛— 14¾	14⅜	14⅜
320,000	Do. 6 p. c. Debentures, repay. February, 1891	100	100 —102	100 —102		
446,100	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. ...	100	103 —106	103 —106	106	...
12,500	Do. 5 p. c. Debentures, 1890, redeem. ann. drawings ...	100	100 —102	100 —102		
367,900	Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900...	100	101 —104	102 —105	104	102
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4⅜— 5¼	4⅜— 5¼		
46,700	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	5 — 5¼xd	4⅞— 5¼xd	5⅜	5⅛
19,700	Fowler-Waring Cables, Nos. 301 to 20,000 ...(£3 only paid)	5	2¼— 2⅝	2¼— 2⅝		
180,227	Globe Telegraph and Trust, Limited	10	8⅜— 8⅞xd	8⅞— 9⅛xd	9	8⅜
180,042	Do. do. 6 p. c. Preference	10	14⅜— 14⅝xd	14⅞— 15⅛xd	14⅝	14 13/16
150,000	Great Northern Tel. Company of Copenhagen	10	15¼— 16	15½— 16	16	15⅞
40,000	Do. do. 5 p. c. Debs. (issue of 1881) ...	100	102 —105	102 —105		
250,000	Do. do. do. (issue of 1883) ...	100	104 —107	104 —107		
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000 ...	10	12 — 13	12 — 13		
5,334	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11 — 12	11 — 12		
41,660	India-Rubber, Gutta-Percha and Telegraph Works, Limited ...	10	18 — 19	18 — 19	18½	18¼
200,000	Do. do. 4½ p. c. Deb., 1896...	100	103 —105	103 —105		
17,000	Indo-European Telegraph, Limited...	25	41 — 43	40 — 42	42	41½
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7		
100,000	Do. do. do. 6 p. c. Debentures ...	100	106 —109	107 —110		
49,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000 ...	10	5¼— 6	5¼— 5⅝	5⅝	5⅜
386 875	National Telephone, Limited, Nos. 1 to 386,875	5	5⅛— 5⅜	5⅜— 5⅝		
49,825	Do. New Nos. 386,876 to 436,700 (£4 only paid)	5	3¾— 4¼	4 — 4⅛		
15,000	Do. 6 p. c. Cum. 1st Preference	10	12¼— 12⅝	12¼— 12⅝		
15,000	Do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	9¼— 10⅛	10 — 11	10⅜	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	⅛— 3/16	⅛— 3/16	5/16	...
9,000	Reuter's, Limited	8	7¼— 8	7⅞— 8¼	8¼	8 1/16
200,750	South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	¼— 3/16	¼— 3/16		
2 ,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3¼ only paid)	5	3¼— 3⅜	3¼— 3⅜		
3,381	Submarine Cables Trust	Cert.	110 —115	110 —115		
78,949	Swan United Electric Light, Limited ... (£3¾ only paid)	5	4½— 5	4½— 5	4 13/16	...
37,350	Telegraph Construction and Maintenance, Limited	12	44 — 46 x	44 — 46	45½	...
130,000	Do. do. do. 5 p. c. Bonds, red. 1894	100	101 — 104	101 —104		
55,000	United River Plate Telephone, Limited	5	4½— 5	4½— 5		
116,000	Do. do. 5 p. c. Debenture Stock... ...	Stock	90 — 94	90 — 94		
100,000	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...		
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	9½— 10½	9½— 10½		
3 0,000	Do. do. do. 5 p. c. Debentures	100	98 —101	99 —102	100	...
30,000	West Coast of America Telegraph, Limited	10	9½— 10½	9½— 10½	9 13/16	9⅝
1 0,000	Do. do. do. 8 p. c. Debs, repay. 1902 ...	100	121 —126	121 —126		
64,572	Western and Brazilian Telegraph, Limited	15	10½— 11	10½— 11	10⅝	10⅜
26,986	Do. do. do. 5 p. c. Cum. Preferred	7½	6½— 6⅝	6¼— 6⅜	6⅜	6⅛
23,986	Do. do. do. 5 p. c. Deferred	7½	4½— 4⅝	4½— 4⅝	4⅝	...
200,000	Do. do. do. 6 p. c. Debentures "A," 1910...	100	106 —109	106 —109		
250,000	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	104 —107		
88,321	West India and Panama Telegraph, Limited	10	2⅞— 3⅛	2⅞— 3⅛	3	2 15/16
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11½— 12	11½— 12	12	...
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	14 — 15	14 — 15		
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	$1,000	122 —126	122 —126		
179,300	Do. do. 6 p. c. Sterling Bonds	100	99 —101	99 —101		
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£2 only paid)	5	1¾— 2¼	1¼— 2		

* Subject to Founders Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 6¾—7¼.—Electric Construction Corporation (£10 paid), 9¾—10¼.—House-to-House Company (£5 paid), 5—5½.—London Electric Supply Corporation, Ordinary (£5 paid), 2⅜—2¾.—Manchester Edison and Swan Company, £9, (£1 paid), 11/- —12/-.

BANK RATE OF DISCOUNT.—3 per cent. (17th April, 1890).

SOME TESTS ON THE EFFICIENCY OF ALTERNATING CURRENT APPARATUS.*

By Dr. LOUIS DUNCAN and Mr. W. F. C. HASSON.

(*Concluded from page* 431.)

Let us inquire for a moment how the increase in the capacity of converters will modify the designs with which we are familiar. In the first place, if we increase the linear dimensions of any type, since the radiating surface only increases as the square while the volume increases as the cube of the dimension, then we cannot suffer the same loss per cubic centimetre of the iron for the large as for the small sizes. We must decrease the intensity of magnetisation or we must decrease the periodicity.

Let us take a typical case. Suppose we have a transformer and double all of its dimensions. If we employ the same induction we will need but one quarter the number of turns in the coils, and as the cross-section of the space occupied by the wire is four times as great, the area of the wire may be 16 times as much. As the length is twice as great, the resistance in this case is one-eighth. But the losses in the iron are, roughly, eight times as great; this we cannot allow, since the radiating surface is but four times as great; hence we must diminish the induction. In fact we must so arrange things that the loss in the larger converter is only four times that in the smaller, in order to work at the same temperature. As at the low induction used the loss due to hysteresis varies nearly as the square of the induction we may take it roughly that the large converter should have an induction of three-quarters of the smaller one. This will modify our figures. Instead of one-quarter the number of turns we will have one-third, and the resistance of the coils will be one-sixth instead of one-eighth, as we can allow four times the loss that we suffered before, we can have, roughly, five times the output.

As a total result we have five times the output with four times the loss, or, as the C^2R effect is not important as compared with the other losses, we can have six times the output with the same fall of potential in the secondary. That is, the efficiency of the larger converters will be greater than the smaller ones of the same design and working at the same temperature, but the output per pound of metal will be less.

Suppose when we increase the size we decrease the number of reversals. Take a case for instance, in which the dimensions are doubled while the reversals are halved, the maximum induction remaining the same. We could have half the turns in the coils, and as they occupy four times the space and are twice as long, the total resistance would be one-quarter, and for the same heating effect we would have four times the output.

If we take losses by eddy currents into account there will be a constant per cubic centimetre, provided the period and maximum induction are constant and the thickness of the plates is unchanged; otherwise they will vary as the square of the induction, with a constant frequency, or inversely as the square of the period with a constant maximum induction. This in practice would make the values of the output for the larger currents given above somewhat greater. What I wish to show, however, is that we are limited by heating considerations and considerations of fall of potential in our secondary in the output of large converters. If we consider the properties of the materials of which converters are made we would, I think, find it most economical to make converters that reach the temperature limit, except for the very smallest sizes.

Many of us have, I suppose, read Mr. James Swinburne's paper read before the British Association at Newcastle last year on the "Design of Converters," and have been struck by the fact that almost all of the converter dimensions given by him are impracticable, either on account of the disproportionate heating of the larger sizes, or the the excessive fall of potential in the secondary. In increasing the size of dynamos we usually increase the output per pound weight, but there is the vital distinction between dynamos and converters that losses occur through the entire mass of the latter, and as we increase the volume we increase the losses in the same proportion. In the dynamo, on the contrary, there are practically no losses in the heaviest part of the apparatus, *i.e.*, the field magnets. As a result, while we gain in efficiency in the larger sizes, yet we must decrease either our induction or the rate of reversal, and the output per pound is not increased.

In the discussion which followed, Mr. NIKOLA TESLA remarked that Dr. Duncan had brought forward some facts which have not been recognised before; for instance, the fact that the loss in the iron of the converter remains perfectly constant with varying loads, and which he thought ought to be so. In converters in which the primary and secondary are put in the closest possible relation, the increase of the primary and secondary is in an almost constant ratio, and since the loss in the iron is due to something like a difference in action of both currents he thought the loss of the iron ought to be constant within certain limits. With regard to the excessive loss in the dynamo machines in the armature, that Dr. Duncan had found, most of this loss is not due to the fact that we must have that loss, but because we must sacrifice a certain amount for the regulation of the machine. Now, the same machine that Dr. Duncan had tested could be given a greater output, and with a loss in the armature of no more than 1 or 2 H.P. But we must work with a highly saturated field in order to obtain a constant potential on the converters. On the other hand, the comparison between the single circuit alternating current and the direct current machine was just, and in the proportion that Dr. Duncan found. On the other hand, if we operated an alternating machine with two circuits, then the output of the machine will no longer be inferior to the direct current machine, but it will be equal to it, if not greater. Now, as regards the general results obtained by Dr. Duncan, he was firmly convinced of their correctness, of course, but also firmly believed that Dr. Duncan had not had the best converter in hand. For he had himself made tests with others of latest make, in which the efficiency of such converters was shown to be much higher than is shown by Dr. Duncan. With the improvements made lately he believed that the new converters have now reached a much higher efficiency.

Mr. H. WARD LEONARD referred to the theoretical discussion which had taken place in Chicago a few years ago as to the relative merits of the continuous and alternating current systems, in which the former had been shown to have a total efficiency of 84·7 per cent., while the latter had been placed at 74 per cent., whereas in his paper Dr. Duncan found it to be only 61 per cent. Mr. Leonard said that the point which was perhaps the most pertinent, and which had been pretty well emphasised of late, was the fact that the average load of a system of lighting generally through a city is such a very small percentage of the connected devices. He knew of one instance where the lighting had not reached the condition which it will later, as regards supplying a much larger connected load than it has at present, and yet the average load for 24 hours was only about 12 per cent. of the connected load. This, of course, brought into very forcible action the efficiency of devices which were low in efficiency under conditions of light load.

Dr. S. S. WHEELER referred to a curious case of interaction between two circuits carrying alternating currents, the effect of which was to cause "pumping," that is, a periodic brightening and dimming of the lamps. These wires were about three miles long and parallel, and after a very extensive investigation it was found that the "pumping" of the lights was due to the alternations on two circuits being nearly, but not

* A paper read before the American Institute of Electrical Engineers, March 18th, 1890.

quite, synchronous; so that when one set of waves caught up with the set of waves on the next wire while passing them, they first drove those waves ahead and then drove them back. This caused the energy of one circuit to first pile up the energy in the other circuit, and then force it down, and thus cause a pumping effect on the lights. That was overcome entirely by placing the wires in pairs properly. That is to say, the two legs of each circuit had not been arranged side by side; one or two of the circuits had been misplaced. But by bringing those together, so that the negative side or leg of one circuit was right along side of the other leg of its own circuit and not mixed up with the wires of any other circuit, the induction was completely neutralised, and that left the lights perfectly steady.

Mr. TESLA, in referring to the point mentioned by Dr. Duncan, viz., how the construction of the converters would be modified when their size is increased, remarked that it was evident that it would be impracticable to increase the size of the converter in the same proportion as its capacity is increased, because as we operate the converters at a constant number of periods we would render a long magnetic circuit transformer very inefficient. A plan was proposed by the speaker a year or so ago to introduce a system in the construction of converters so that all would have the same length of magnetic circuit, no matter whether the converters were large or small. He believed that this would be the proper way of constructing all converters on one system, and that the present method of constructing converters was not right, for every different capacity of converter had a different length of magnetic circuit, and we knew well if one converter is adapted to, say, sixteen thousand reversals, another one with a different length of magnetic circuit is not adapted to the same number of reversals. A year ago they had begun to make all converters of the same length of magnetic circuit so as to render them equally adaptable for the same number of alternations, no matter what their capacity was, so that if, for instance, a converter was wanted that had ten times the capacity of a small 20-light converter they would practically put in one converter so many multiple circuits as are required to get the capacity desired. Mr. Tesla thought that the results obtained by Dr. Duncan referred to an apparatus which had been in use for some considerable time, but the advances that had been made in that line during the last year alone had been so enormous that one would not recognise this plant at all. Thus the converters at present can be made to have less than half the leakage that they had previously. In other words, it meant practically that a converter could be run with a double load, and likewise the machines had been increased to very nearly double their original capacity.

Dr. DUNCAN thought Mr. Tesla's idea of keeping the same length of the magnetic circuit hardly proper. He had worked out the design of a number of converters, and thought that the same period should be retained in the circuit, and the converter should be designed which would give the maximum possible efficiency. For a converter of given capacity one must have a definite period. There is a definite period which, with the given proportions of iron and copper, corresponds with the given capacity of converter; but if we simply increase the cross section of the iron without increasing the length of the circuit we keep the same cross section of copper, which is not a good practice. We have to change both the copper and iron, and he did not think it would be very interesting to design a large number of converters for any given output. As for the efficiency of the plant which was tested, the plant was sent on in November, and was supposed to be the latest plant which was produced by the Westinghouse Company. He had since heard that the efficiency of the converters had been greatly increased. The losses in the converters could undoubtedly be greatly decreased, especially for larger sizes. As to the relative efficiency of the two plants, it was to be remembered that he had simply taken a 750-light plant, and one dynamo was supposed to be always connected with the circuit in a station of ordinary capacity, that is, of more than twice 750 lamps. We would certainly have the advantage of having at least two dynamos, one of which could be disconnected when the load had reached its minimum, and the efficiency, therefore, would be greatly increased; and also in comparing the efficiency of alternating and continuous plants, we must remember that the business that is catered to by these two plants is very different, that the load diagram of the alternating plant is very different from the load diagram of the continuous current plant. There was a great discrepancy between the curves and the figures of the two. An alternating plant takes up the cream of the business, so to speak. It takes up business in which they get the maximum output for a given number of lamps wired, and in that way we must not calculate the efficiency of the alternating and continuous current plants in order to compare them. If so, we are favouring the continuous plant very much. If one can put into a continuous current station an alternating plant which will get business that will pay, it is undoubtedly proper to put that plant in. In the same way, if there is an alternating plant and it is so situated that it can run more economically with a continuous current plant, a continuous current plant ought to be put in. But as the business stood at present a combination of the two plants was undoubtedly theoretically the most efficient.

Mr. TESLA, in reply to Dr. Duncan, stated that he proposed not to keep the length the same and vary the section, but simply to vary the section of the copper, at the same time varying the section of the iron. They had plates, for instance, which contain so many multiple circuits. These plates were so made that the coils could be just as well put in as one single circuit transformer, a form of construction invented by Mr. Albert Schmid, of the Westinghouse Company, and in this way they had practically a number of independent transformers, and the only diminution of the capacity of such transformers is that they had a somewhat smaller surface. We might then allow a little higher capacity for that diminished surface.

Mr. FREDERICK DARLINGTON drew attention to the fact that one system uses the 50-volt lamp and the other system is forced to use a 100 or 110-volt lamp, and that by the same skill in construction of lamps and the same advance in the art of manufacturing lamps, the 50-volt lamps represent about 20 per cent. more efficiency than the 100-volt lamps. He also stated that they were manufacturing for a considerable time a converter that gave a leakage of ·12 ampere on every 40-light converter, and that they had recently, since certain analyses had been made of the iron and the quality and the method of annealing of it had been improved, succeeded in reducing that leakage from ·12 to ·7 ampère. He also remarked that they were getting out of the total amount of lamps wired on a circuit of the United States Illuminating Company, of New York, 5·8 hours per lamp, which is about 23 per cent. All those points, if taken into account, would, he thought, make the efficiency of the alternating current come much higher than would appear at first thought.

Dr. DUNCAN, in reply to Lieut. John Millis, stated that in England the rate of alternation is determined very greatly by the size of the unit in which the distribution is made. For large units a low rate was commonly employed. It would be found that in most of the continental and English systems the rate of alternations had been decreased as the size of the converter was increased. For a large converter a comparatively low rate should be used, and, as in this country, small converters had generally been employed, the rate was very much greater than if the converter had been large.

Dr. MICHAEL I. PUPIN inquired of Dr. Duncan whether he knew of any experiments that had been made lately for the purpose of finding out how much of the lost energy was due to eddy currents, and how much to magnetic hysteresis.

Dr. DUNCAN remarked that he was not prepared to give any figure on that, because he was experimenting on it at the present time. He was working now to weed out the eddy currents and to determine the effect

of hysteresis for different periods of reversal. There were no data at present to tell whether the loss on the iron is due to viscous or static hysteresis. If the change in magnetic force were made at a very low speed then hysteresis due to time would not come in at all, if, at the present speed, it would come in.

Mr. LEONARD, referring to his previous remarks, stated that he had been brought to select, in the instance noted, the most exceptional one he knew of as being the future condition of supply of all kinds. In New York City, which, of course, was the most exceptional in the other direction, the Edison station here had instead of five, nearer eight hours average load, which, however, may be somewhat due to the advantages derived from the sale of motive power.

Mr. JUSTUS B. ENTZ pointed out that the losses due to eddy currents and hysteresis could be determined by employing different thicknesses of discs and testing in each case.

Mr. TESLA stated that the results brought out by Dr. Duncan strengthened him in the idea which he always had, that ultimately the whole loss in the iron would resolve itself into the loss due to the eddy currents. The loss in the iron is constant at all loads; on the other hand, Dr. Duncan finds that the loss is proportioned to the square of the electromotive force, which would be precisely the case if the loss in the iron were due to eddy currents. He thought that an argument for this view.

Dr. DUNCAN thought that as for distinguishing between the hysteresis and eddy currents with different thicknesses of plate, unfortunately Ewing had found that, as far as the time hysteresis is concerned, it depended on the thickness of the plate independent of the eddy current, so that it would be impossible to distinguish it in the way suggested by Mr. Entz.

PHENOMENA OF ALTERNATING CURRENT INDUCTION.*

By Prof. ELIHU THOMSON.

ABOUT three years ago I had the pleasure of bringing to the attention of the American Institute of Electrical Engineers, at its annual meeting, certain phenomena of the repulsive action between conductors, such as coils of wire travered by alternating electric currents. It was then noted that if such a current be sent through a circuit wound as a coil, and either provided with an iron core, or not so provided, and permitted to induce in another coil or circuit, a current under conditions which allowed a lag or displacement of phase of the latter from its theoretical position, a repulsive effort would be exerted, tending to remove one coil from proximity with the other, or to deflect one of them to a position such that the plane of the coils would be at right angles—one to the other.

Many modifications of the arrangements of the coils were described, and apparatus based upon the principle of inductive repulsion, as I called it, were touched upon. I need not now enlarge upon these matters. It may suffice to say that current indicators and potential indicators or voltmeters have been constructed embodying the principle as applied to the quantitative measurement of alternating currents. Arc lamps have been made in which the regulation of the carbons has been effected by the repulsive action of a coil traversed by the current fed to the lamp, or by a derived current around the arc, acting on a closed band or circuit movable with the regulating and feeding frame of the lamp. Various forms of alternating current motors have been made, in which the revolving portion is composed of coils arranged to be closed upon themselves, and inductively acted upon by the currents in what may be called the field or inducing coils connected with the alternating current source. The principle has been applied in other apparatus, such as regulating mechanism for alternating currents, and in electric meters.

It is my purpose this evening to bring before the Institute some experimental apparatus showing the action of inductive repulsion in some of its phases; following this by a brief account of a number of other effects somewhat allied to it, with experimental demonstrations of the same. Some of these experiments were to be seen at the Paris Exposition of last year in connection with my exhibit there, and others of them are more recent still, while still others have never been shown at all in public. The field is a fruitful one, and there is not time to touch upon other than the more striking, and perhaps interesting, phases of the actions exhibited, which are susceptible of modification to a great extent by changes in proportion and arrangement of apparatus.

I may here revert to one experiment which is almost a repetition of one I made about five years ago. If a copper disc or closed coil be balanced in front of another coil and parallel thereto, it will be noticed that on passing a current into the second coil the disc or closed coil will be repelled slightly, and if the current be afterwards shunted or cut off there will be a slight attraction. By opening and closing the shunt so as to put the current successively on and off the coil, there will be alternate repulsions and attractions exhibited. Let the current, however, be so put on and off very quickly, and the attractive effect will become less than the repulsive effect, and the disc or closed coil will be driven away or bodily repelled. Replace now the intermittent current by an alternating current which reverses many times per second, and the repulsive effect alone is noticed, provided that the disc or closed coil is of sufficient mass and conductivity to allow currents of high self-induction to be set up in it, whereby such disc or coil or current in it may, as it were, exert a controlling influence upon the magnetic field in immediate proximity to it.

The amount of this repulsive effect may, under favourable circumstances, become so great as to give with moderate current densities a very considerable pressure or force.

I have selected some particular instances of this action for our experiments, as it will be understood that time is too short to show many variations of the effect as found in numerous experimental trials.

Placing a copper ring over a coil which has been wound upon an iron core, and passing an alternating current through the coil, gives so much repulsive effect that the ring is thrown forcibly away and up into the air (fig. 1). Or, again, the ring may be supported for a moment in free air, though its condition is one of unstable equilibrium. Further, we may arrange a string or thread to so guide the ring that it cannot move laterally though free to fall towards the alternating coil (fig. 2). It is in this case supported in the magnetic field of the coil and away from it. It takes a position of balance between the repulsive effect and its own weight, which are opposed forces. As a curious variation, another copper ring (fig. 2) may be added under the former, to which it seems to be attracted as though magnetised, after which both rings are supported as one. The explanation is very simple. The currents induced in both rings are in the same direction at any instant and produce attraction. The bearing of this will be seen in later experiments where rotary actions are produced.

Copper plates are but imperfect discs, and act as closed coils. Aluminum rings, having much less weight than copper, might at first be expected to be more readily supported, but it must be remembered that the conductivity of aluminum is much less than that of copper, and hence that since the effect depends on current induced, and retardation of phase or lag of such current, copper is the better on account of its high conductivity.

By attaching the closed ring or coil to a balance beam (fig. 3), we are able to measure the amount of

* Abstract of a lecture delivered before the American Institute of Electrical Engineers at Columbia College, April 2nd, 1890.

force exerted with different currents, and different materials or constructions.

Such measurements show very decidedly that the repulsive effort depends on the strength of the current in the inducing coil, and in the ring or closed coil, and on the relation of the position of the waves of induced current in the closed coil or ring with those of the inducing current. The effects are, properly considered, magnetic repulsive effects of the opposing fields of the induced and inducing currents relatively.

When the closed coil or disc is mounted so that it can only turn on an axis in its plane, then the repulsion resolves itself into a deflection of its plane to a position at right angles to the plane of the inducing coil, or, more strictly, to parallelism with the direction of the magnetic lines set up by such inducing coil. The effect of the control exhibited by such a closed circuit of good conducting power over the magnetic field of the inducing coil, is seen by interposing such closed circuits between the inducing coil and another coil acting as a secondary and feeding an incandescent lamp (fig. 4). The light of the lamp is cut down and extinguished thereby, as the alternating field is now almost completely shielded from the secondary. The coil feeding the lamp undergoes a slight repulsion. This is easily exhibited by placing in a glass jar with water a lamp and coil, the lamp wires being connected with the coil terminals, and so loading it that it just sinks to the bottom of the jar. Placing this above the inducing coil so as to bring it into the alternating magnetic field, is attended not only with the lighting of the lamp under water, but there is noticed a repulsion or floating of the lamp to a certain point (fig. 5), at which its tendency to sink just balances the repulsion exerted. So long as the lamp remains so suspended in the water its brilliancy is constant, notwithstanding that the strength of the inducing current be raised or lowered considerably. It is, of course, unnecessary to use water to balance the lamp coil, a beam and counter-poise weight will suffice (fig. 5A).

In utilising the repulsive action for obtaining movement from alternating currents, the closed coil or circuit may be mounted in various ways.

A convenient form is one in which a bent core of iron wire or plates, which may be a ring, is wound over with insulated wire at a portion only of its surface. A closed band or secondary is pivotally mounted so as to pass over the curved core, and also over the wire-covered portion if moved around the pivot by a suitable carrier (fig. 6). A spring or weight may tend to cause the closed band to pass over the wire-covered portion of the core. Currents sent in the wire coil produce repulsion and movement of the closed band about the pivots to a position on the core removed from the coil.

This apparatus, and some of its modifications, is a valuable reactive coil which gives a smooth variation, and hence is called a "smoothly acting reactive coil," for it enables us by changing the relation of the closed band or secondary circuit to affect the inductive resistance, as it may be termed, or the impedance of the coil wound on the core; the changes being made by swinging the closed band on its pivotal support by a suitable operating handle. It so varies the effects in an alternating circuit as to represent those of variable resistance in a continuous current circuit; but it does this without much loss of energy, and not by steps, but through the finest gradations. The power is greatly increased by the provision of a movable iron armature for the core, centrally placed and pivoted, carrying the closed secondary coil upon it.

It is easy to see that by placing on a laminated armature core a series of coils which can be suitably short-circuited by a commutator, and placing such armature between poles of alternating magnetic polarity, or, better, surrounding such armature by coils for producing directly in it an alternation of magnetic states, while the magnetic circuit is completed by an outside magnetic circuit of laminated iron, we have obtained a rotary motor for alternating currents, which may be termed a transformer motor, since the armature currents are induced, and not obtained, from the outside.

But by properly constructing such a machine it is not necessary to have a commutator, if we are content to start the motor initially by some means, for we may close the armature coils on themselves, pass alternating current through the field coils so as to establish an alternating field in which the armature exists, and it will be found that the machine will turn in the direction in which it has been started, and run up to a speed depending on the construction. I have constructed a number of such machines, some of which are self-starting without a commutator. They are made self-starting by special features of construction. Whether they can be made of high or fair efficiency remains to be seen. Using only one alternating current, they can, of course, be used on existing lines.

There are a number of curious effects to be described which depend on a shifting or propagation of magnetic lines of force.

Many of these effects were worked out conjointly by Mr. M. J. Wightman and myself, and some of the ways of exhibiting them are due to the skill of my workmen carrying on the construction of apparatus.

The principles may be briefly stated as follows:—

1. If two or more closed circuits are similarly affected inductively by an alternating magnetic field, they will attract one another, and tend to move into parallelism.

2. Iron or steel masses placed in an alternating magnetic field give rise to shifting magnetism, or lines of force moving laterally, and may, therefore, act to move closed circuits in the path of such shifting lines.

3. Closed circuits in alternating magnetic fields, or fields of varying intensity, give rise to shifting magnetism or lines of force moving laterally to their direction, and may, therefore, act to move other closed circuits in the path of such lines.

4. Iron or steel masses may, when placed in an alternating magnetic field, interact with other such masses, or with closed electric circuits, so as to produce movement of such masses or circuits relatively, or give rise to tendencies to so move, the effects depending on continual adaptations of shifting magnetism and retained magnetism relatively.

The experimental demonstration of these principles can be carried out with very simple apparatus. The explanations of the actions which occur in accordance with known principles are in many cases very evident, and in others are arrived at with a little study. Nevertheless, the experiments illustrate in a marked manner properties of matter and peculiarities of magnetic action which will probably never be fully understood unless the nature of the ether and its relations to what we call matter are discovered.

We will return to the case of the ring attracting another ring to it. Here we have the case of like currents in parallel direction producing attraction. Such an action can be made continuous. We have only to place a ring or plate over the alternating current coil or pole of its core and then bring a copper disc free to revolve on pivots into proper position relatively thereto. This can best be done by placing the ring or plate so as to be somewhat to one side of the pole, so as to shade it in part, as it were, while a part of the pivoted disc is placed under it, or over it, in front of the alternating field pole (fig. 7). The disc then revolves from the unshaded portion of the pole towards the shaded portion where the closed ring or plate is placed.

The actions are due to lines of magnetic force at each alternation of current in the magnetising coil below meeting a retarding influence or opposition to their development over that part of the pole shaded by the copper ring or plate, owing to currents induced therein. The copper disc is the seat of similar currents, but chiefly about those portions not shaded by the ring or plate. Owing to self-induction these currents in ring and plate tend to persist into the period of reversal of the field. This gives rise to a movement of those portions of the disc where current is flowing into a position directly adjacent to the ring or the currents flowing in it, an action which is repeated at every

alternation, and results in a revolution of the disc. While this explanation is probably the simplest, it must be borne in mind that it is but an expression of a set of magnetic actions or changes in the magnetic field; such magnetic field being the resultant of the changing force of the original alternating inducing field and of the magnetic effects of the currents set up in the ring or plate and the disc, both of which latter have a retarding action due to self-induction of the currents in them.

If now two discs be used instead of one (fig. 8), it will be found that they may each shade a portion of the pole, and that the discs if made to overlap, will both revolve in opposite directions relatively.

An iron disc may be substituted for one of the discs above and used with the fixed plate or ring below it, and so be caused to revolve, and its position can be changed so that it is in a plane vertical to the plane of the plate or ring (fig. 9). Also, it may be similarly used

teresis," or coercive force, or magnetic friction, retards the propagation of the magnetic wave. By laying a large file flat-wise against the alternating magnet pole, at about the middle of the file (fig. 10), two discs of copper or iron may be kept revolving; or one each of copper and iron held over those portions of the file projecting from the pole of the magnet over which it is laid will revolve. The iron disc may be held vertically and the copper horizontally or flat-wise to the file.

Cast iron behaves like steel, though more feebly. A ring of cast iron having a closed coil wound on one part (fig. 11), can be laid on the pole of the alternating magnet coil, and it will rotate an iron disc concentric with it if the placing of the closed coil portion of the ring is not made so as to bring it either over the pole or diametrically opposite that point, the best effect being obtained when it is alongside of the pole.

A small motor of a curious type has been made, utilising the principle of shading the pole by closed

FIG. 1.

FIG. 2.

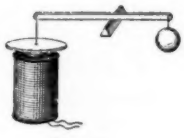


FIG. 3.

FIG. 4.

FIG. 5.

FIG. 5a.

FIG. 6.

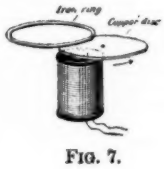


FIG. 7.

FIG. 8.

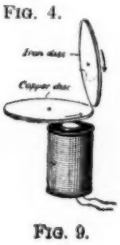


FIG. 9.

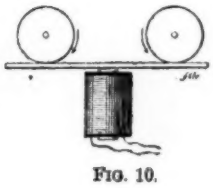


FIG. 10.

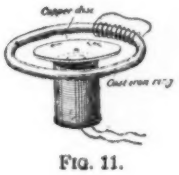


FIG. 11.

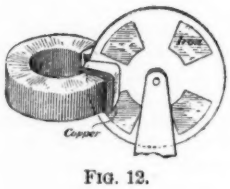


FIG. 12.

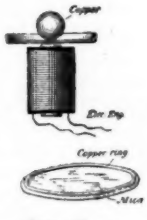


FIG. 13.

FIG. 14.

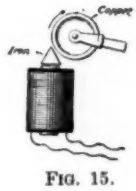


FIG. 15.

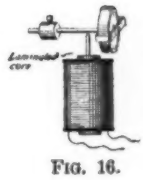


FIG. 16.

in relation to the revolving copper disc. In fact, the positions of two copper discs pivoted so as to be revolvable, or of a copper and iron disc, may be greatly varied and effects of rotation obtained.

If we vary the experiment by placing a closed coil around a part of an iron core upon which is also wound a coil which can be put into an alternating current circuit the effects obtainable are similar to those described above; that is, the structure becomes capable of revolving copper or iron discs held near it. The direction of revolution is such as to indicate a propagation of magnetism or magnetic polarity at a retarded rate through that portion of the iron core covered by the closed coil. In this respect a bar of iron, unlaminated or not divided, is the same as a core surrounded by a closed coil, for it is also capable of causing the rotation of the discs, when such a bar is abutted to a laminated core alternatively magnetised, or when such a bar is surrounded at part of its length only by the magnetising coil. A bar of steel substituted for the iron, even if well laminated, is able to cause brisk rotations of the copper or iron discs.

With hardened steel the action is the more marked, a file serving for the experiment. Here the "hys-

circuits. A laminated ring (fig. 12), is wound over with wire, but has a slot cut through it dividing the ring and causing it to present two pole faces opposite to each other at the cut part. Each pole is arranged by a set of closed copper bands to be "shaded," as I term it. A copper disc free to turn, introduced by one edge into the slot, turns rapidly and exerts some power.

Removing the disc, it is found that a silver coin can be inserted into the slot, and will be drawn into it and propelled with some force through the same, while a lead coin, or coin of base metal, will be scarcely affected. This is due to the vigorous currents which can exist in the silver, owing to its high conductivity, while the very low effect of the lead is due to the opposite cause.

To obtain a rotary effect on a copper disc we can, however, simplify matters very much by using no closed circuit at all, nor even a steel piece. We may place the disc partly over the alternating pole and then hold over the disc a bundle of iron wires or unwound core, taking care to offset its axes to some extent from that of the pole towards which it and the disc are presented. The result is at once a rapid revolution of the disc in the direction of the offsetting.

The rotary effects are utilised in the construction of

electric motors and meters of more or less merit. They are capable of very great variation by changing the forms and relations of the devices used.

Some curious modifications of the effects are found in the revolution of copper balls or cylinders. A hollow copper ball may be laid on a plate of copper (fig. 13), or within a ring of the same metal and set in gyratory movement, its direction of rotation as well as the position of its axis of rotation depending on the relation of the ball and the plate on which it rests, or the ring which encloses it in relation to the alternating pole which is used to set it in movement.

It will even rotate on a horizontal axis while resting on a plate of copper; this requires that it rub its equator upon such surface and overcome the friction.

Placing the ball in a vase of water in which it floats, and supporting the vase over the pole upon which has been laid a plate of copper partly covering the pole, gives vigorous rotation of the ball in the water. Several balls of various sizes may be placed in the vase or a copper dish substituted for the plate, or the ball and dish both used together (fig. 14). The effects of these latter are both amusing and instructive.

We need scarcely stop to consider that these actions are brought about just as the movements of the discs were set up by induced currents and shifting magnetic lines that are retarded by the closed circuit currents set up in the plates, rings, &c., which have been employed to modify the field.

But, as we have shown, it is not necessary for obtaining some of these effects that the field be modified by closed circuit currents. Slight changes in the position or shape of parts may be sufficient to give rise to rotatory effects. Thus we may place a cone or wedge of iron on the alternating pole (fig. 15), and hold near it a copper ring mounted so as to be able to revolve. The ring in this case is best provided with a laminated iron interior which supports it and enables it to be easily mounted on a shaft. The copper cylinder revolves, and its direction is such that it seems to be blown around by a blast from the edge of the wedge or point of the cone.

A curious electrical gyroscope is constructed as follows: A vertical pivot projects from the centre of the alternating pole (fig. 16), upon which pivot is hung a horizontal rod, bearing on one side of the pivot a copper frame, in which is carried a copper ring or wheel with an iron inner portion, such ring or wheel being delicately pivoted in the frame in the usual way. The rod bears on its other end the counterpoise or balance weight. The copper frame bearing the ring is placed in an inclined direction with reference to the horizontal. Under these circumstances, rotation is given by the alternating field in which the instrument is placed, and the properties of the gyroscope are exhibited. It is needless to say that a little ingenuity may modify the instrument in form or lead to the construction on similar principles of a variety of curious devices, receiving their movements from the actual space, as it were, in which they are placed, and without direct connections of an electrical or mechanical character.

There is a growing tendency among electricians to regard the effects of what is called an electrical current in a conductor to be due, in large part at least, to a movement of particles or to a transmitted strain which has its place entirely outside the wire or conductor, and in the space around such conductor. The wire and current in it are regarded simply as the central core of a set of disturbances in the medium surrounding it, by which medium the energy of the current is actually transmitted, if the current itself is not merely an effect of such a set of disturbances in the surrounding medium.

Viewed in this light the phenomena we have been considering are seen to be simply the result of modifying these outside effects by conducting or magnetic masses placed in the medium subject to disturbance. The coil conveying the current sets up a changing set of strains in the ether around it, or rather the coil itself is only the centre of such strains transmitted into the medium surrounding the wire from the source of current used, which may be a dynamo located in a central supply station. The changing set of strains around the coil used in the experiments can set up current in other conductors than the coil subject to their action. Thus are produced the induced currents in the copper rings, balls, plates, &c., used. Such currents react on the medium and modify the distribution of strains, and so give rise to the movements and other phenomena displayed.

The relation which exists between a primary inducing coil and a secondary coil in an inductive apparatus or transformer is of the same nature. The secondary coil is merely a conductor immersed in the medium which surrounds the primary coil. The latter, and the wire leading to it from the source of current, is but the core of a set of disturbances or strains in the ether surrounding it, and in which the secondary coil is immersed. Hence the coils, though insulated from each other, are yet both immersed in the medium whose transmitted strains are the real expression of electrical energy transmitted. The result of this relation is, that, were it not for the fact that the coils must necessarily be made of imperfect conductors, the amount of energy transmitted to a secondary coil from its primary could be unlimited—it might be thousands of horse-power, and the iron core of the transformer be only of such size as to be easily lifted in the hand.

Let us imagine the primary and secondary coils of an induction apparatus made of pipe, through which a refrigerant is circulated, or around which a powerful refrigerating action is exerted, such as might be obtained by the evaporation of liquified gases, and in such case the resistance of the coils would become very small indeed. The coils could carry large currents without loss, and the amount of energy obtained in the secondary would almost keep pace with the energy supplied to primary. A remarkable example of this wonderful capacity for energy transmission is seen in some transformers for electric welding, in which 20,000 to 30,000 watts, or from 30 to 40 H.P. are transferred to the secondary coil from the primary, apparently, while the iron core or magnetisable core is of quite moderate dimensions. In fact, the iron core has but little to do with the capacity for transmission of energy by induction, though it affects the E.M.F. set up in the turns of wire of the coils.

Could we imagine an open coil without iron, composed of two interwound coils of copper wire or tubes insulated from each other, and kept at the lowest possible temperature so as to practically abolish the resistance of the copper, we would have an apparatus of the very highest efficiency for the transfer of electrical energy from one circuit to another, and one which could be of very moderate size, and yet transfer enormous amounts of such energy, to be used for lighting, metal working, or other purpose.

There has only been time in this discussion to touch upon a few salient features of our subject, about which a volume might be written at the present time, the object being to bring to the notice of the Institute rather the experimental demonstrations only, stripped of such theoretical considerations as would, if incorporated in this paper, have taken up much more than the space allotted to it, and perhaps have exhausted the interest of the hearers.

School of Practical Engineering.—On Saturday last Prof. Francis Elgar, Director of Her Majesty's Dockyards, distributed the certificates gained by the students in the Crystal Palace Company's School of Practical Engineering. A very encouraging report showing the prosperous state of the school was read, and Prof. Elgar delivered an interesting and instructive address to the students. The examiners for the term were Mr. F. Wentworth-Sheilds, M.Inst. C.E., and Mr. J. P. Knight, A.M.Inst. C.E. The chief distinction was gained by Mr. A. M. A. Struben, a student from South Africa, who had qualified himself by his work and examinations for the bronze medal of the school.

PADDINGTON AND THE ELECTRIC LIGHT.

PROTEST AGAINST THE DECISION OF THE VESTRY.

AT the meeting of the Paddington Vestry, on Tuesday last, Mr. Churchwarden Jackson in the chair, the revised report of the Electric Lighting Committee was presented, upon which Col. BARCHARD proposed the following resolution:—

"That, as the Metropolitan Electric Supply Company's terms are the most favourable, and that company works both the high and low pressure systems, and bearing in mind that it has practically accepted the provisional order as amended, as well as the condition to deposit £20,000; and, moreover, has not solicited the Board of Trade to act independently, the Vestry do discontinue its opposition in respect of that company, and that the resolution of the 18th February, 1890, be varied accordingly."

Mr. MARK H. JUDGE proposed an amendment to the effect that at this period of the Session it would be unwise of the Vestry to commit itself to any particular company or companies at present, and appointing a special committee to report in time for the Vestry to proceed with the matter for the Session of 1890.

A long discussion ensued, and Mr. Judge's amendment received 18 votes, but was lost, and the resolution of Col. Barchard was declared to be carried, 14 voting for it and 10 against it.

Mr. JUDGE then handed in a protest against the decision of the vestry, the protest pointing out that on February 18th the vestry, when 47 members were present, had passed a resolution instructing their solicitor "to oppose all applications for provisional orders;" that the Metropolis Local Management Act, 1855, section 57, provided that under the circumstances stated, "no resolution or other Act of any vestry shall be revoked or altered at any subsequent meeting, unless such revocation or alteration shall be determined upon by a majority consisting of two-thirds of the members present at such subsequent meeting;" and that the number of members present when the division on Colonel Barchard's motion was taken was 27.

The above and other facts have been embodied in a letter which Mr. Judge has sent to the President of the Board of Trade.

ELECTRICAL TRADES SECTION, LONDON CHAMBER OF COMMERCE.

THE annual meeting for the election of members and for the transaction of the ordinary business of the section took place on Monday last at Botolph House. The members of the committee were increased from 33 to 48. Mr. Crompton in retiring from the position of chairman, which he has held during the past year, said the work of chairman was not as easy perhaps as it looked, although in the future it would be comparatively plain sailing, as they had arranged things into better order than they were at first. A great deal had not been accomplished, still he hoped a few things that were in hand would be completed. One or two solid pieces of work had been done, one in their action in asking the Board of Trade to establish a standardising laboratory, and which is almost completed. Some good had been done in standardising screws, they had got in the thin edge of the wedge, and already 80 per cent. of the electrical trades were using it, and he hoped to induce the kindred trades to adopt the British Association screw. A statistical society had been commenced for electrical statistics, letters were being sent out, and some valuable information would be gained from the system of reciprocity. In conclusion, he referred to the advantages already secured as regards railway rates, and trusted that during the next season there would be a greater attendance of members at the meetings of the section.

On the motion of Major-General Webber, seconded by Colonel Jackson, Mr. Crompton was re-elected chairman for the ensuing year.

Major Flood Page and Mr. Garcke were elected vice-chairmen, and after a short discussion on the conciliation committee the meeting terminated.

LEGAL.

Re Edward Moross.—A receiving order was made in this matter on the 25th March, at Manchester, the debtor, who describes himself as a medical electrician, carrying on business at 184, Oxford Street, Manchester. His liabilities were £1,023 7s. 4d., and the assets are estimated to produce £13. The debtor stated that he was an American by birth, and he last practised his business in that country at San Francisco. Asked to explain what was meant by a medical electrician, the debtor referred the Assistant Official Receiver to a number of pamphlets he had supplied him with. The specialities he claimed to alleviate by electricity were blindness, deafness, and loss of speech. He took apartments at 342, Oxford Road, Manchester, about Christmas, 1888. In May, 1889, he removed to London, and entered into partnership with Dr. S. Swyer. He took a house at 17, Euston Square, and he became involved in financial difficulties. He then returned to Manchester. The debtor spoke of having challenged a certain gentleman to a duel for having blackened his character. In his deficiency account he scheduled a sum of £1,010, of which £80 were stated to be law costs in an action against a Mr. Parkes, £40 as charges in actions against a Mr. Williams, and £66 in actions against Dr. Swyer. The remainder of the deficiency of £1,010 represented the cost of advertisements and lectures in connection with the establishment of his practice here and in London. The assets disclosed are solely on account of book debts. The bankrupt alleges as the cause of his failure: "Loss sustained through actions at law, brought against Parkes, of Southport; Williams, dentist, of Manchester; and Dr. Swyer, of London;" also to loss sustained to his business profits in London. Before he went to London his income was from £50 to £60 a week, and his expenditure was from £5 to £7 per week. That he added, was before he went to London; it was not that now. The examination was adjourned.

An Electric Lighting Dispute.—In the Divisional Court, on Friday last, an appeal was heard from a decision by Mr. Justice Lawrance, in Chambers, in a dispute between the electric engineering houses of Phillips and Crompton, Mr. Witt and Mr. Banks being the counsel engaged.

In June, 1889, Messrs. Phillips supplied to the order of Messrs. Crompton a quantity of electric wire, called "C" wire, intended to be used in lighting Chelmsford with electricity. Cromptons paid the cost, over £1,200, less £54 17s., and further received some insulated wire to the value of £1,350. In January the Cromptons issued a writ against Philips for damages, alleging that the "C" wire was not equal to warranty, and in February Phillips issued a writ against Cromptons for the balance above named, and the cost of the insulated wire, total £1,405 18s. 8d., applying for judgment under Order 14. Cromptons thereupon applied for the consolidation of the actions, and that Phillips's claim should be set up as a counter-claim to their claim for damages for breach of warranty, the Master at Chambers refusing to consolidate the actions, and giving judgment for the amount named, staying execution until the damage action was tried. The order was appealed against; Messrs. Phillips asking for payment under their judgment, and Cromptons for the consolidation of the actions. Mr. Justice Lawrance thereupon directed that upon Cromptons bringing £500 into Court within seven days the order of the Master should be set aside, and the actions consolidated, the defendants having liberty to defend; otherwise the Master's order to stand. The money had not been paid into Court, and the application now was by Messrs. Phillips that the order of Mr. Justice Lawrance be valid, and by Messrs. Crompton that the actions be consolidated and untrammelled by the order to pay £500 into Court. Their Lordships decided that the actions should be consolidated, costs to be costs in the cause.

NEW PATENTS—1890.

5191. "Improvements in and connected with apparatus for detecting electrical radiations." W. LUCAS and T. A. GARRETT. Dated April 3.

5219. "Improvements in electric arc lamps." F. V. ANDERSEN. Dated April 3. (*Complete.*)

5235. "Improvements in electric generators and motors." W. B. SAYERS and J. SAYERS. Dated April 5.

5274. "Improvements in telephonic and telegraphic transmission." C. D. ABEL. (Communicated by the Société Generale des Telephones (Reseaux Telephoniques et Constructions Electriques) and V. Picon, France.) Dated April 5.

5344. "Improvements in apparatus for measuring the strength and electromotive force of electric currents." H. H. LAKE. (Communicated by M. M. Garver, United States.) Dated April 8. (*Complete.*)

5368. "Improvements in telephony, and in apparatus therefor." M. G. KELLOGG. Dated April 8.

5369. "Improvements in telephony, and in apparatus therefor." M. G. KELLOGG. Dated April 8.

5400. "Improvements in dynamo-electric machines." R. SCHORCH. Dated April 9.

5409. "Improvements in electrical arc lamps." S. CAPPILLERI, K. KURMAYER, J. GOLDBERG, and R. LATZKO. Dated April 9.

5474. "Improvements in regulating and controlling the resistance of electric currents." H. LYON and H. J. LESLIE. Dated April 10.

5518. "Improvements in or relating to electric incandescence lamps. C. PRICE. (Communicated by F. H. Hadfield, South Africa.) Dated April 11.

5540. "Improvements in apparatus in which electrical measures are obtained by the aid of a wire or filament heated by the passage of a current." F. H. W. HIGGINS. Dated April 11.

5562. "Improvements in dynamo-electric machines." W. EMMOTT and J. H. RIDER. Dated April 12.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1889.

1480. "Electric meters and motors." A. WRIGHT, G. H. ALDERTON, and G. J. PHILPOTT. Dated January 28. 11d. Consists essentially of electric meters and motors worked by a combination of specially-designed electro-magnets, which produce a shifting magnetic field of force when energised by an alternating current, and suitable metallic bodies or armatures placed in the shifting field so produced. 6 claims.

2168. "Improvements in or appertaining to electric meters." W. P. THOMPSON. (A communication from abroad by H. O. Tudor, of Luxemburg.) Dated February 7. 8d. The governing apparatus is composed of a pendulum which establishes and interrupts the contact at equal intervals, and connects any source of electrical energy with the motive apparatus, working the various meters by means of a special distributing line. The motive apparatus in each meter consists of a simple ratchet wheel governed and actuated by a hooked lever, the latter being worked by the armature of an electro-magnet, which is alternately magnetised and demagnetised by the current that is alternately established and disestablished by the governor. The ratchet wheel advancing one tooth at each contact describes a complete revolution at the end of a certain number of contacts, and since the wheels of all the motive apparatus have the same number of teeth, they will all have made a complete revolution in the same time, so that a uniform motion is obtained throughout the series. 2 claims.

2313. "Means for applying electricity during exercise for therapeutic or other purposes." H. N. LAWRENCE. Dated February 9. 8d. Relates to means for applying electricity during exercise for therapeutic or other purposes, and consists in providing apparatus and machinery suitable for exercising the limbs and other portions of the body with electrical connections and electrodes so that currents of electricity may be passed through the body or portions thereof at the same time and during the whole or part of the period that such body or portion thereof is being exercised by the machine. 1 claim.

2331. "An improved apparatus for economically effecting the double decompocition of certain substances by the aid of electricity." W. H. DOWLAND and W. MILLS. Dated February 9. 6d. Claims:—1. The method of and apparatus for decomposing haloids by electricity, and collecting the products of decomposition, substantially as described. 2. The apparatus with two porous divisions between which the free haloid undergoing electrolysis is contained. 3. The use of two separate liquids in the manner and for the purposes described.

3103. "Improvements in electrical measuring instruments." W. HIBBERT. Dated February 21. 8d. Consists of a magnetic system set of two or more hard steel magnets, arranged so as to form a nearly closed magnetic circuit, the air space being not more than about one-sixteenth of an inch. With this special magnetic system, is provided a framework on which is wound a number of convolutions of very thin insulated wire. By means of suitable connecting studs and a switch, one or more of these convolutions can be put into action, as may best suit the exigencies of the measurements to be made. 2 claims.

12286. "An electric current meter." Sir CHARLES STEWART FORBES. Dated August 2. 8d. A secondary cell is so arranged as to receive the whole or a part of the main current passing, and stores a proportional part of the same. The main, or a shunted part of the main current passes round an electro-magnet or equivalent and thereby operates a switch contact so as to break the discharge circuit from the secondary cell when the current is passing. Upon its cessation the switch contact discharges the secondary cell through a variable resistance and an electro-magnet or polarised relay constructed so as to start a clock, watch or any equivalent motor operating a suitably graded dial or other similar device. The motor remaining in action until the secondary cell is discharged, when the stored current can be read off upon the dial and is a measure of the total current passed through the mains. 8 claims.

19420. "Improvements in alternating current electro-magnetic motors." H. H. LAKE. (Communicated from abroad by Nikola Tesla, of New York.) Dated December 3. 8d. Claims:—1. In an alternating current motor the combination with an armature wound with closed coils, of main and supplemental field magnets or poles, one set of which is adapted to exhibit their maximum magnetic effect simultaneously with that set up in the armature by the action of the other, as set forth. 2. In an electro-magnetic motor the combination with an armature of a plurality of field or energising coils, included respectively in main circuits adapted to produce a given difference of phase and supplementary or secondary circuits adapted to produce an intermediate difference of phase, as set forth. 3. An electro-magnetic motor in which the field and armature magnets exhibit equal strength or magnetic quantities under the influence of a given energising current, as set forth. 4. In an alternating current motor the combination with field and armature cores of equal mass of emergising coils containing equal amounts of copper, as set forth.

19426. "Improvements in the construction and mode of operating alternating current motors." H. H. LAKE. (Communication from abroad by Nikola Tesla, of New York.) Dated December 3. 8d. Relates to that form of electro-magnetic motors in which one of the elements, the armature or the field, is provided with coils forming independent energising circuits, through which from any suitable source or sources, alternating currents differing in phase, are passed for the purpose of producing in the motor a progression or rotation of the points of maximum magnetic attraction. 9 claims.

19946. "Improvements in telegraph transmitters." O. D. LA DOW. Dated December 11. 8d. Relates to telegraph transmitters, and more particularly to that general class of transmitters in which a single movement of the operator, as, for instance, the depression of a single key or lever, will automatically cause any desired number of variations or impulses of the electric current to be transmitted, by means of a suitable conductor, to the receiving instrument and there record, or produce the same; and it has for its object, to produce a simple, cheap and effective mechanism whereby those objects may be attained. 7 claims.

19883. "Improvements in electrical secondary batteries." J. K. PUMPELLY and F. D. THOMASON. Dated December 10. 8d. Claims:—1. An electrolyte for electric batteries, consisting of cellulose made from fibre saturated with the electrolytic solution. 2. The combination with an electric battery of cellulose made from fibre packed around the electrodes thereof and saturated with the electrolytic solution. 3. The combination with an electrical secondary battery and the negative and positive electrodes thereof consisting of a suitable number of plates alternating one with the other, of cellulose made from fibre packed between and around said plates and saturated with the electrolytic solution, as set forth. 4. The combination with the electrodes of an electrical secondary battery, of metal conductor plated, the active material of which was applied thereto in a dry powdered state, and held in position by a suitable porous pad while the same was placed in the solution and subjected to an electric current and formed. 5. The method of applying active material to the plates of an electric secondary battery consisting of applying to said plates the active material in a dry powdered state and placing against each plate so treated a pad before said plates are immersed in the electrolytic solution. 6. The method of applying active material to the plates of an electrical secondary battery consisting of applying to said plates the active material in a dry powdered condition, and placing against each plate so treated a pad made from cellulose made from fibre, before said plates are immersed in the electrical solution. 7. The combination with the electrodes of an electrical secondary battery the plates of which had the active material applied thereto in a dry powdered state which was held in place by a porous pad while said plates are being formed, of cellulose made from fibre packed in said battery and saturated with the electrolytic fluid, as set forth.

CORRESPONDENCE.

Vulcanised Fibre.

Anent your reply to "W. N." in issue of the 18th inst. *re* vulcanised fibre, if your querist would coat the material with a solution of shellac or paraffin wax, this will render the fibre impervious to the atmosphere and make it a really good insulator.

Jno. Giltoore.

April 19*th*, 1890.

Insulation Resistance.

(*Translation.*)

I have read in your issue of April 11th, 1890, the article on insulation resistances. Allow me to say that I do not entirely agree with the same. I have before had occasion to observe a difference in the results of experiments on insulation with a variable difference of potential, and at a uniform temperature. The experiments of M. Forderreuther appear to me to be very similar, and I have admitted their conclusions, until proof to the contrary is given. However, immediately after the publication of these experiments I endeavoured to trace the cause of the phenomena. I have met with great practical difficulties in doing so, so that I am unable to give any results; but I am continuing my experiments, and I would ask you in the mean time to accord to me the credit of desiring to arrive at a just conclusion in the matter.

J. Laffargue.

[We have much pleasure in inserting the writer's letter and shall be pleased to know the results of his further experiments, though we feel sure that our own conclusions will be verified.—EDS. ELEC. REV.]